Single Aisle
TECHNICAL TRAINING MANUAL
T1+T2 (IAE V2500) (Lvl 2&3)
POWER PLANT IAE V2500

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POWER PLANT IAE V2500

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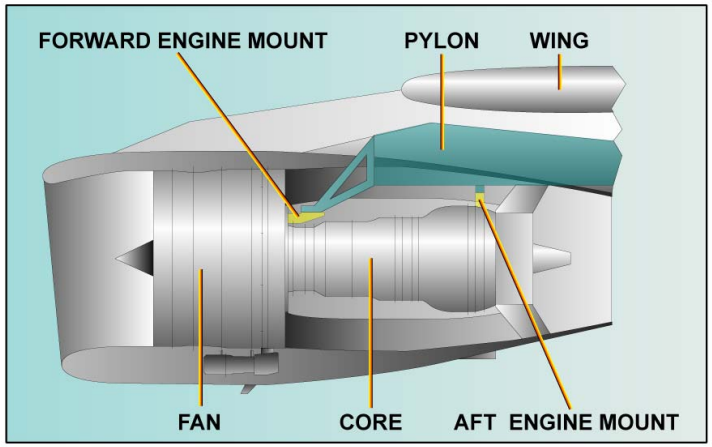
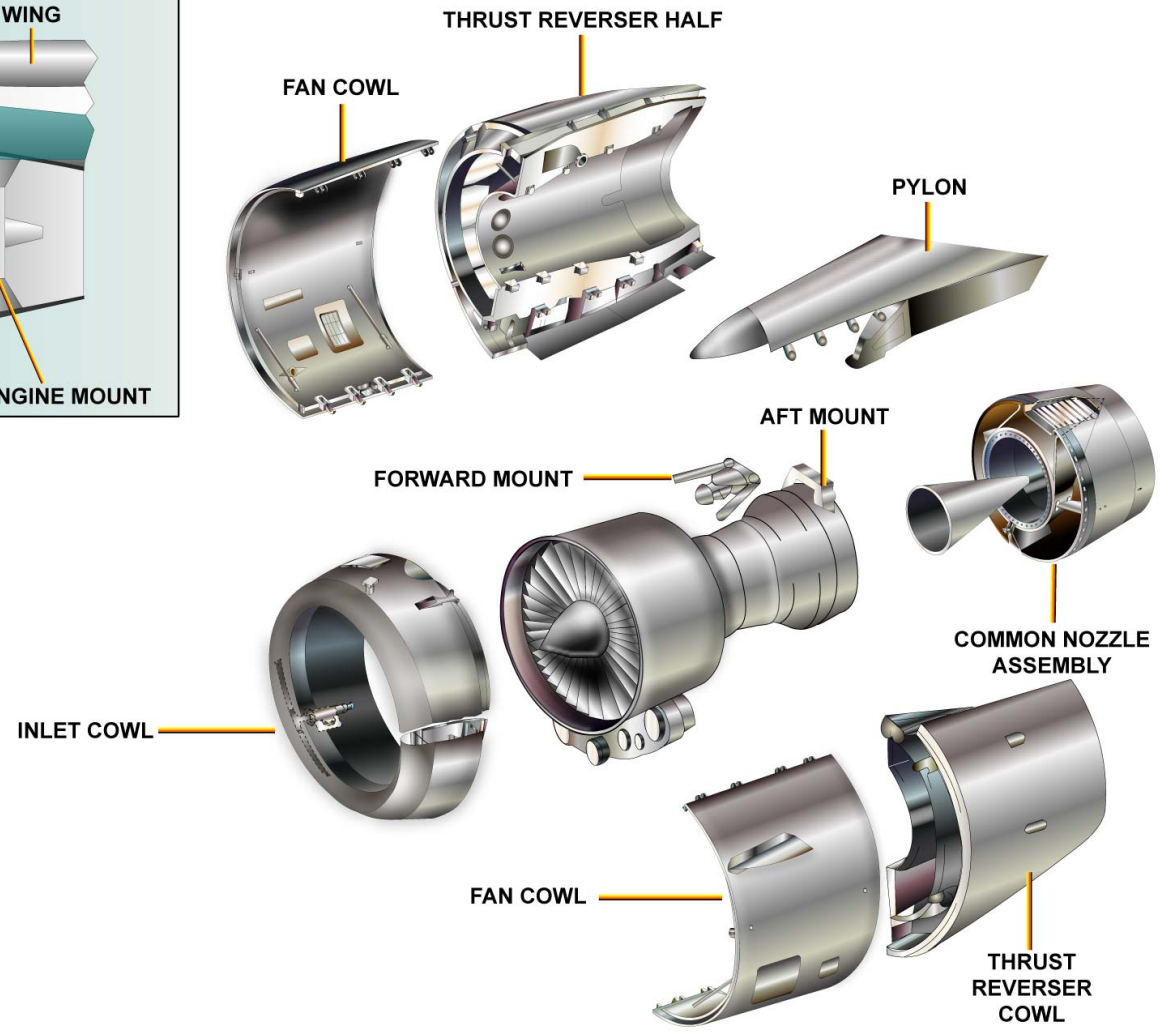
POWERPLANT SYSTEM COMPONENT LOCATION (2)

SYSTEM OVERVIEW

The IAE V2500-A5 engine is a two-spool, axial-flow, high-bypass-ratio turbo-fan power engine. The V2500-A5 can power all aircraft types of the Single Aisle family except the A318. V2500-A5 engines are available in several thrust ratings.
All the engines have the same basic configuration. A programming plug on the Electronic Engine Control (EEC) changes the available thrust.
The power plant installation includes the engine, the engine inlet, the exhaust, the fan cowls and the reverser assemblies. The pylon connects the engine to the wing structure. The engine is attached to the pylon by FWD and AFT mounts.





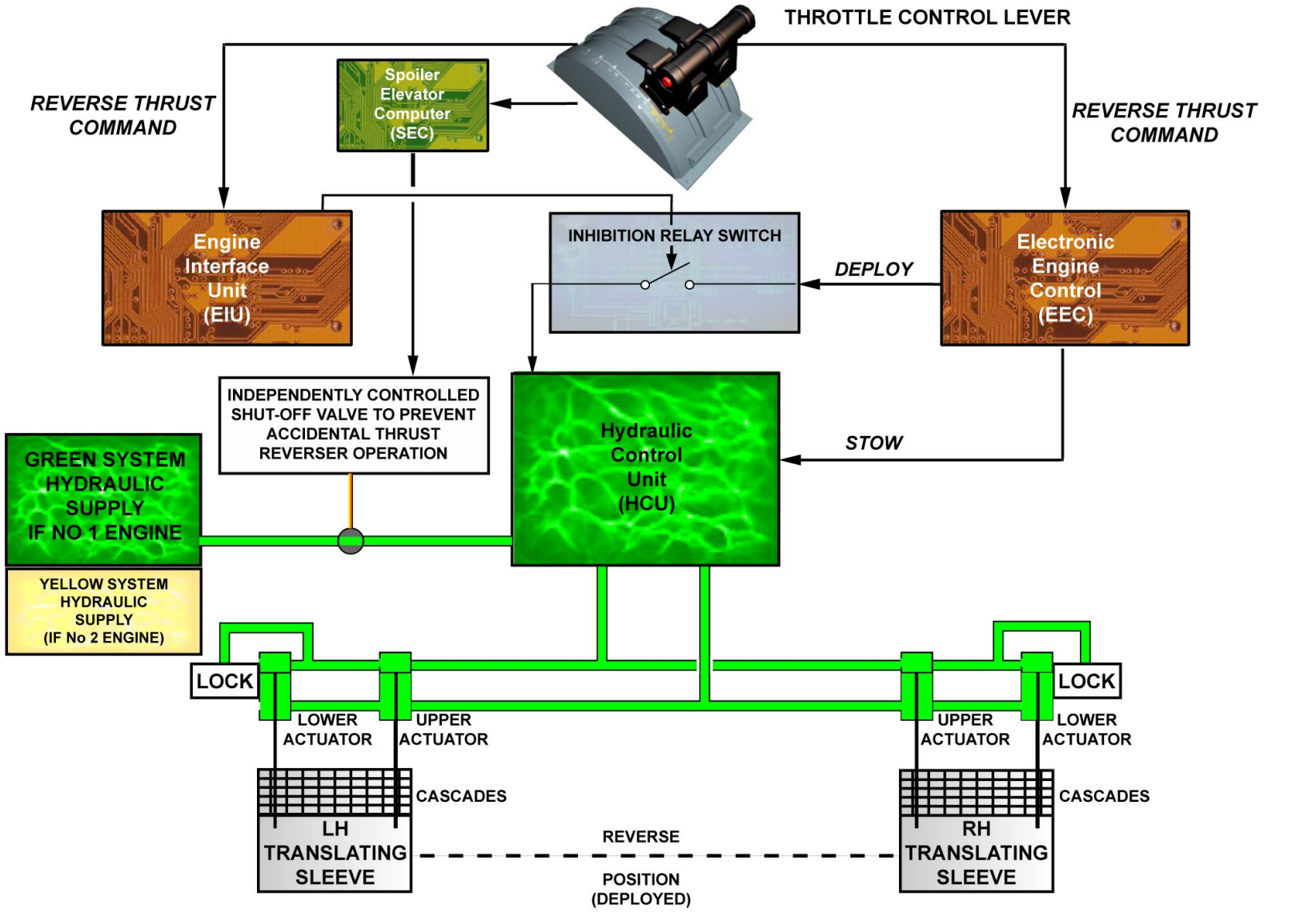
SYSTEM OVERVIEW

POWERPLANT SYSTEM COMPONENT LOCATION (2)

SYSTEM OVERVIEW (continued)

THRUST REVERSER SYSTEM

Reverse thrust is controlled by the EEC. A manual selection of the reverse is done when the flight crew lifts the latching levers on the throttle control levers. The reverse thrust command is sent to the EEC and the EIU. The DEPLOY command from the EEC goes through the INHIBITION RELAY (controlled by the EIU) as a second level of protection against accidental deployment.
In relation to commands from the EEC and the EIU, a Hydraulic Control Unit (HCU) supplies hydraulic power to operate the thrust reverser. The thrust reverser assembly has 2 hydraulically operated translating sleeves. The translating sleeves are each energized by 2 actuators. When the translating sleeve moves aft during deployment, it lifts blocker doors that redirect the engine fan airflow.



SYSTEM OVERVIEW - THRUST REVERSER SYSTEM

THRUST REVERSERS STOWED
-TRANSLATING SLEEVE CLOSED-

THRUST REVERSERS DEPLOYED
-TRANSLATING SLEEVE OPEN-

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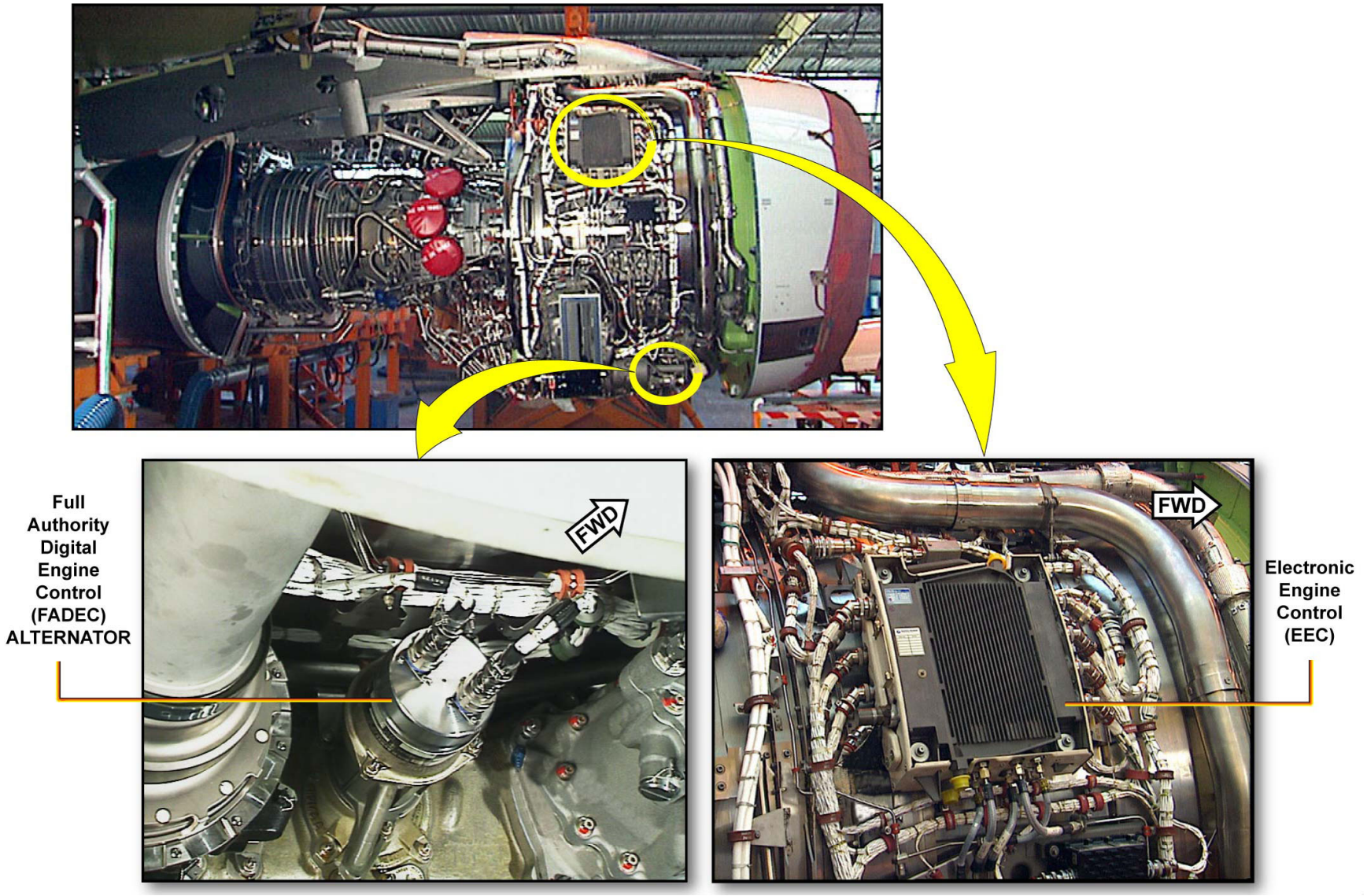
POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION

The engine system components are at the following locations.

FADEC

The EEC is on the RH side of the fan case. The FADEC alternator is on the gearbox.



COMPONENT LOCATION - FADEC

POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION (continued)

STARTING

Two ignition boxes are on the RH side of the engine core. The air starter is on the RH side of the gearbox front face.

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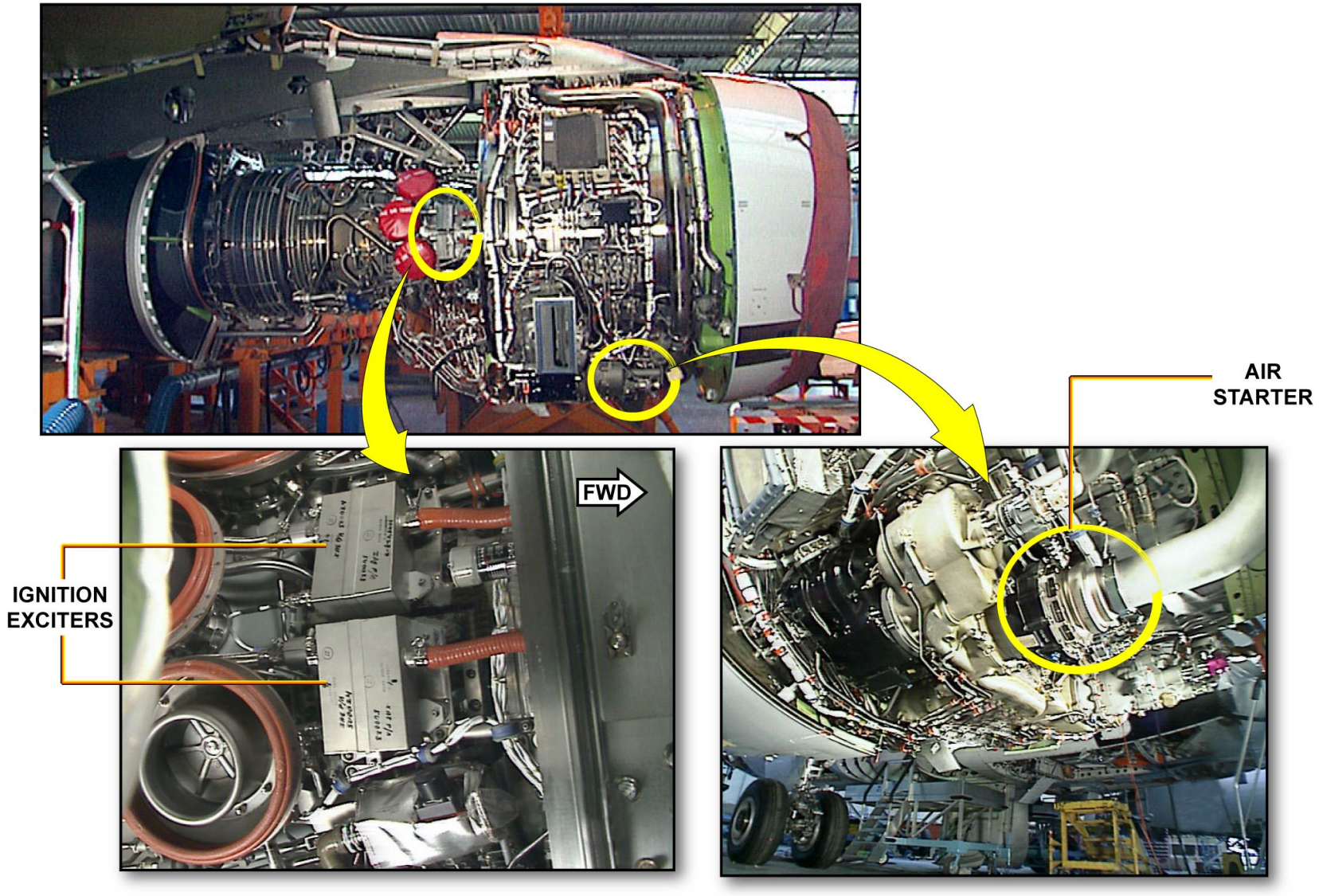


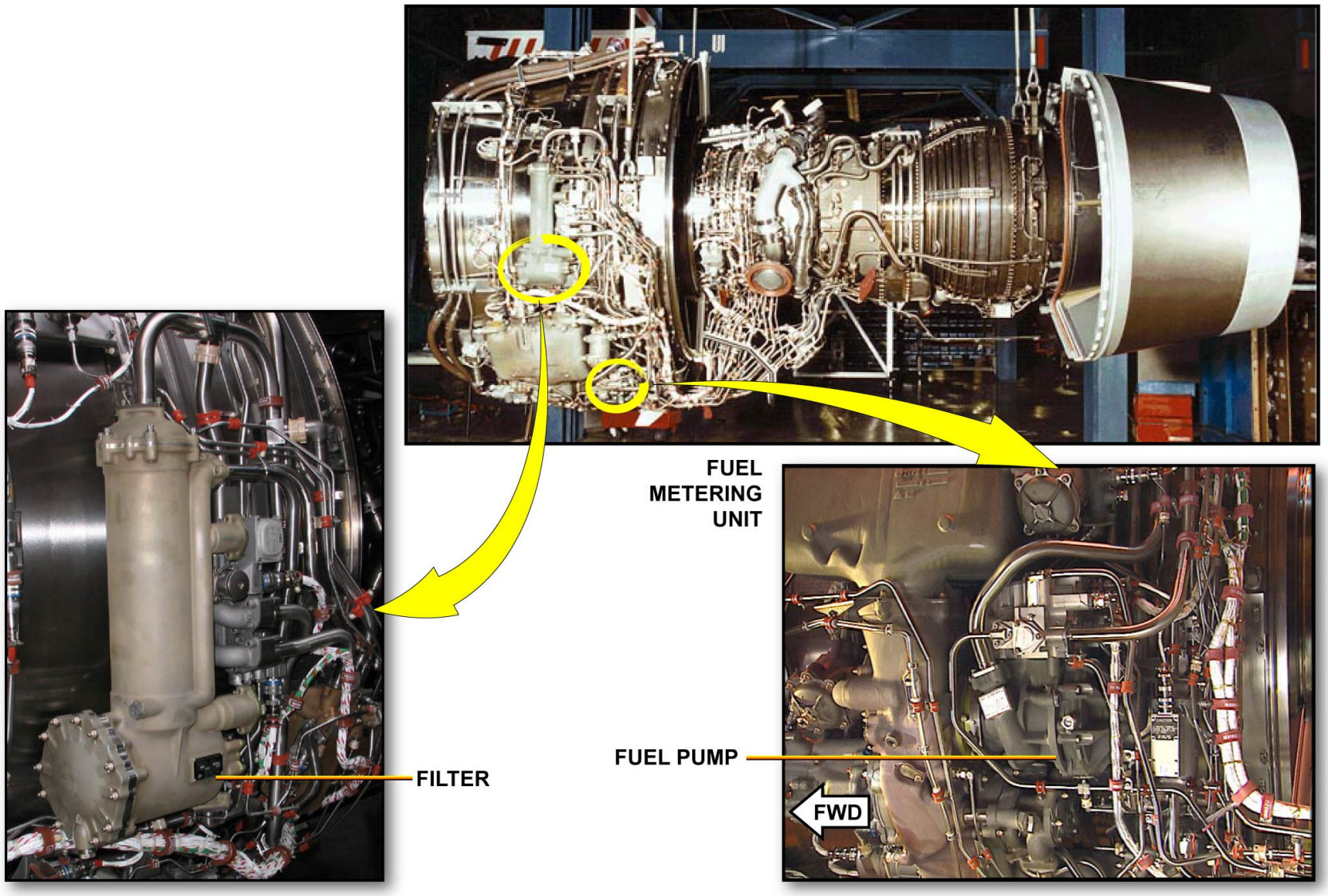
COMPONENT LOCATION - STARTING

POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION (continued)

FUEL

The primary components of the fuel system are on the LH side of the engine.
The fuel pump and the FMU are on the gearbox. The filter is on the LH side of the fan case.



COMPONENT LOCATION - FUEL

POWERPLANT SYSTEM COMPONENT LOCATION (2)

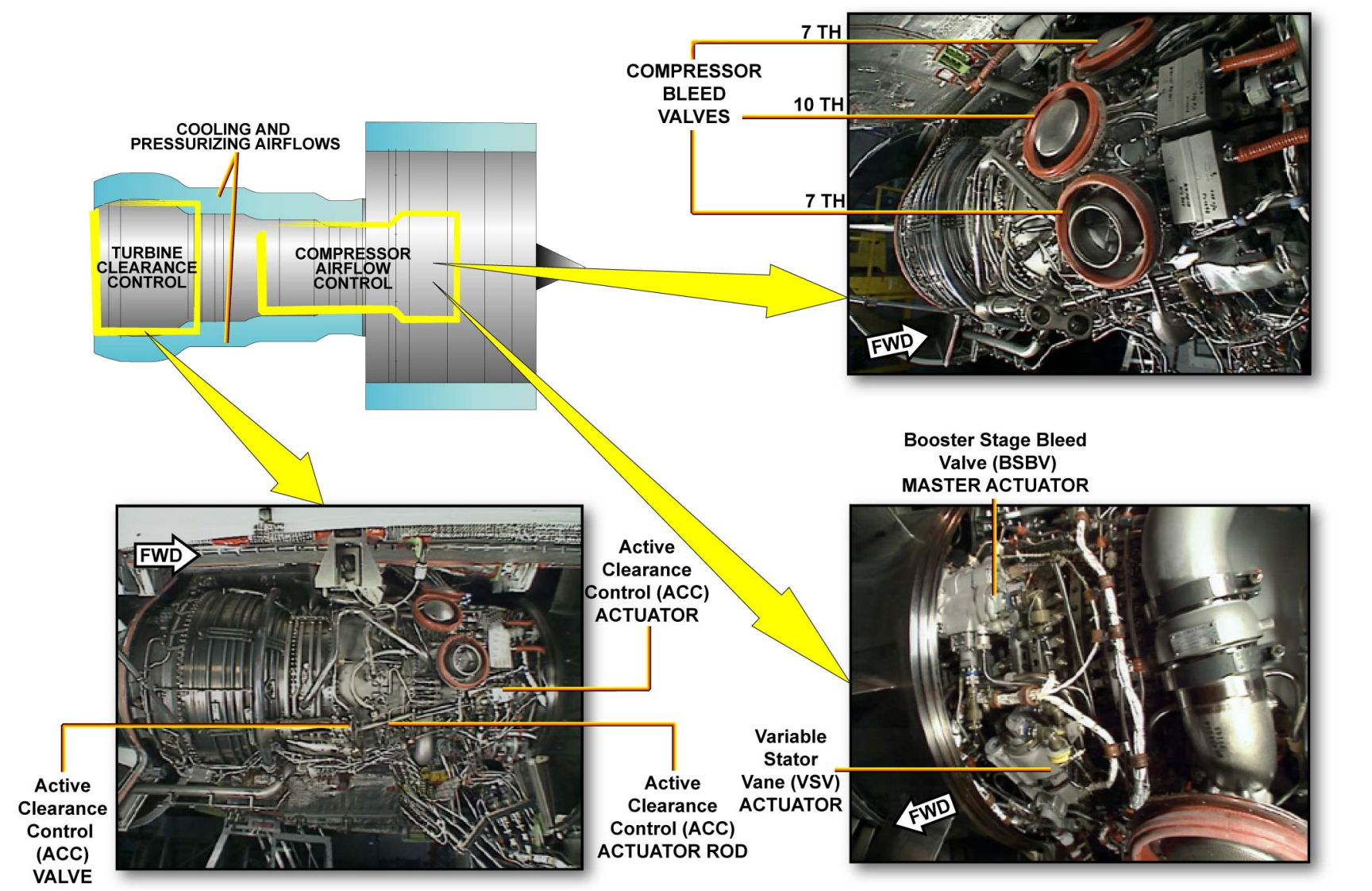
COMPONENT LOCATION (continued)

AIR

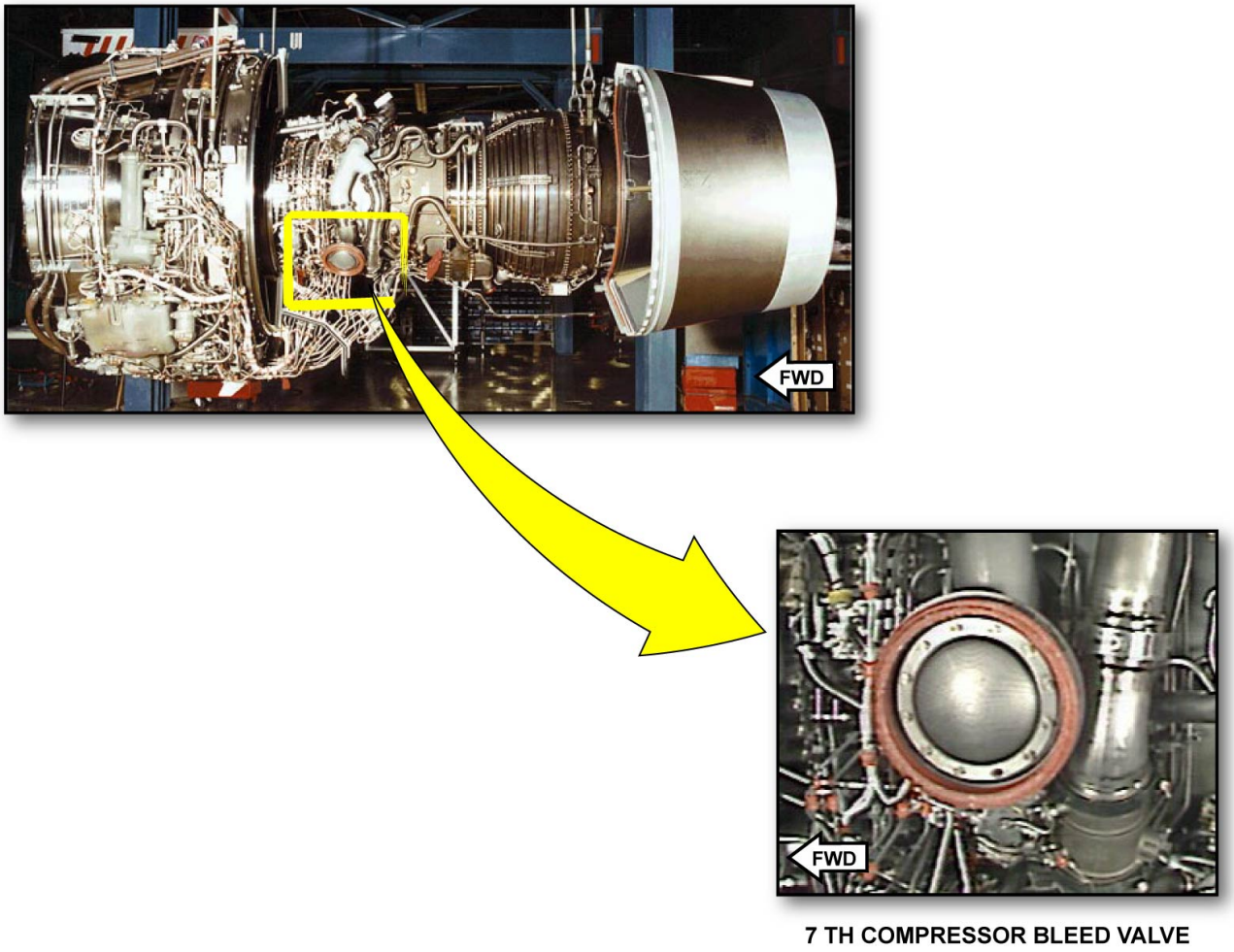
The next picture shows the compressor airflow control system and the turbine clearance control system.

On the LH side, there are 2 bleed valves for the 7th stage and one for the 10th stage of the HP compressor.

On the RH side, one more bleed valve is installed for the 7th stage.



COMPONENT LOCATION - AIR



7 TH COMPRESSOR BLEED VALVE

COMPONENT LOCATION - AIR

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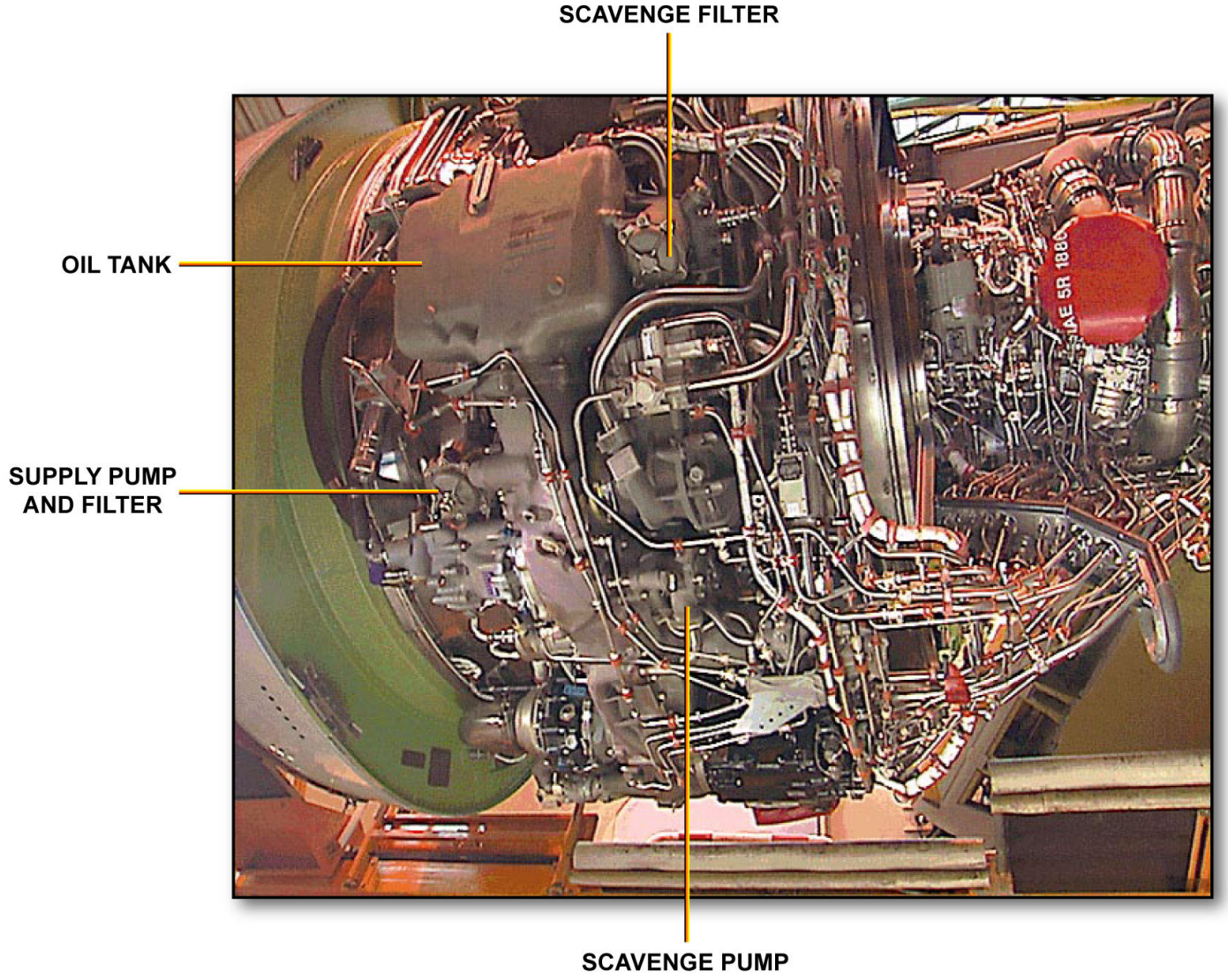
POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION (continued)

OIL

The oil tank, the pressure pump, the scavenge pumps and the filter are on the gearbox.



COMPONENT LOCATION - OIL

POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION (continued)

THRUST REVERSER

The hydraulic shut-off valve is in the front lower part of the pylon. The HCU is installed on the pylon above the engine centerline, immediately forward of the C-duct. Access to the HCU is done from the left side.

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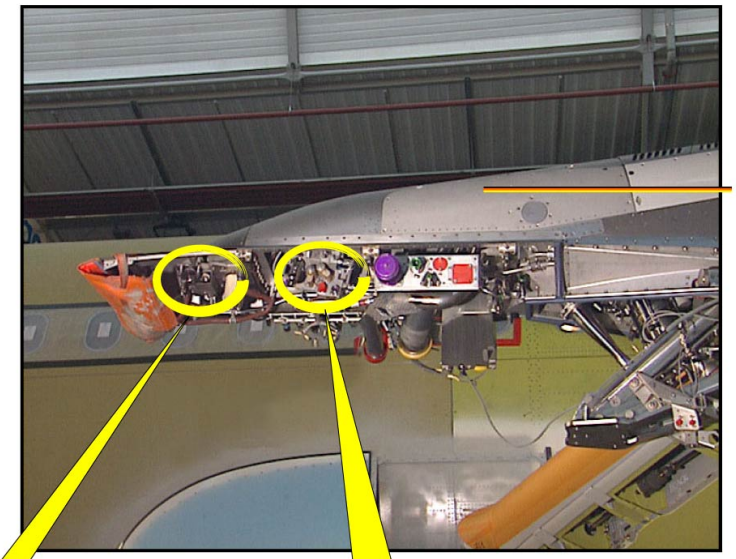
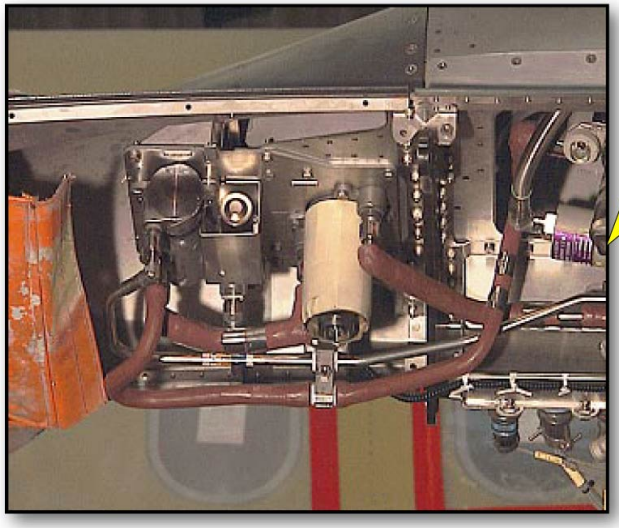
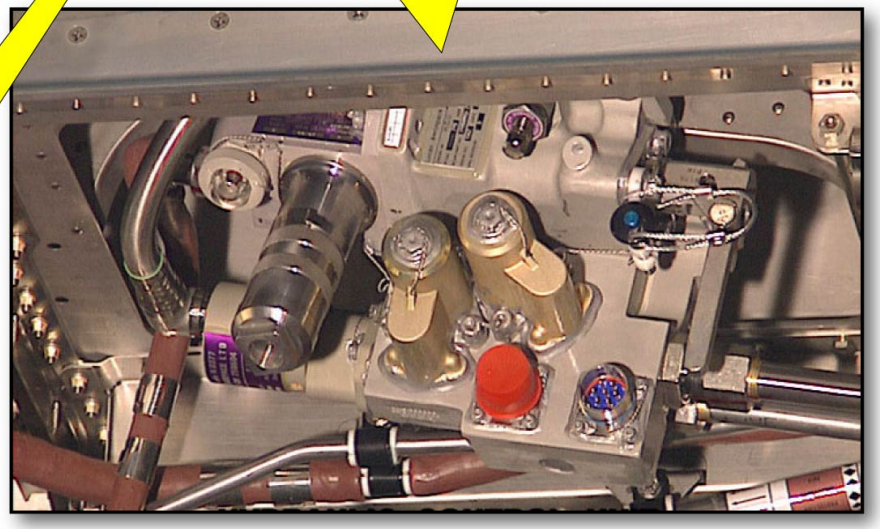


HYDRAULIC SHUT OFF VALVE



HYDRAULIC CONTROL UNIT



COMPONENT LOCATION - THRUST REVERSER

ENGINE SYSTEM CONTROL & INDICATING (IAE V2500) (2)

LOCATE CONTROL/INDICATING IN COCKPIT

FADEC POWERING / ENGINE CONTROLS

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POWER PLANT DRAIN PRESENTATION (2)

GENERAL

The power plant drain system collects fluids which can leak from the pylon, the engine accessories and drives. The fluids collected from the power plant can be fuel, oil, hydraulic or water. They are discharged overboard through the pylon drains and the engine drains.

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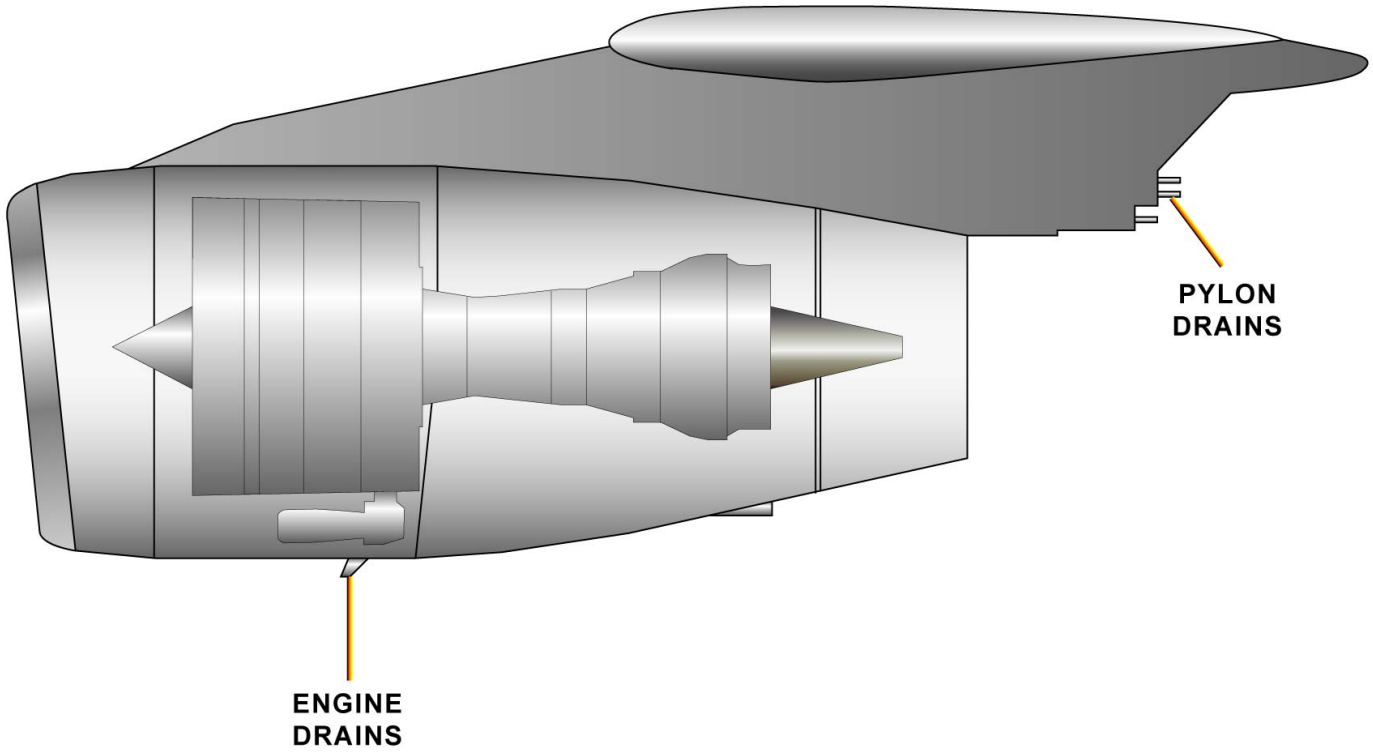

GENERAL

POWER PLANT DRAIN PRESENTATION (2)

PYLON DRAINS

The engine pylon is divided into 7 compartments; various systems are routed through these areas. Any leakage from fluid lines is drained overboard through separate lines in the rear of the pylon.

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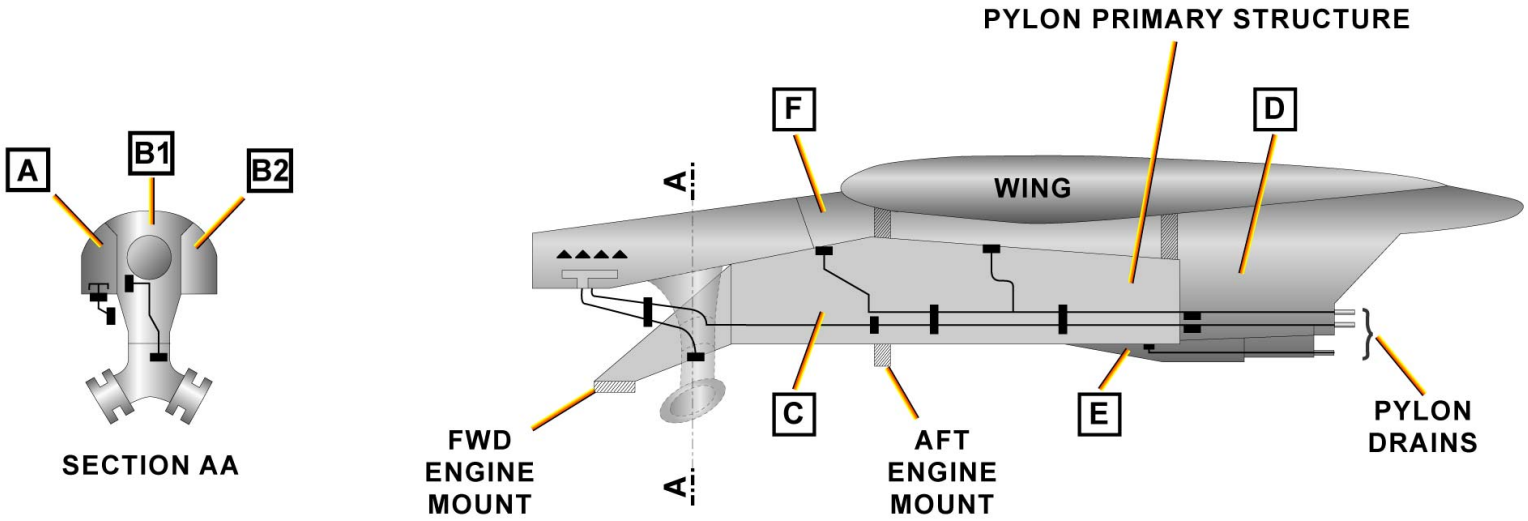

DESIGNATION	ZONE	SYSTEMS
FORWARD FAIRING	A B1 B2	FLAMMABLE FLUIDS (FUEL, HYDRAULICS) BLEED AIR (HI AND LO TEMPERATURES) ELECTRICS
PYLON BOX	C	HYDRAULICS WITHOUT COUPLINGS FIRE EXTENGUISHER BOTTLES
REARWARD SECONDARY STRUCTURE	D	HYDRAULICS LIMITED ELECTRICS
LOWER FAIRING	E	NONE
PYLON TO WING CENTER FILLETS	F	FUEL (ZERO-LEAKAGE COUPLINGS) ELECTRICS

PYLON DRAINS

POWER PLANT DRAIN PRESENTATION (2)

ENGINE DRAINS

Fluid drained from the oil tank scupper, fuel diverter valve and gear box mounted accessories, is independently routed to the drain mast. The fuel drains from the core engine accessories, are routed through a separate drain line which passes through the bifurcation panel.

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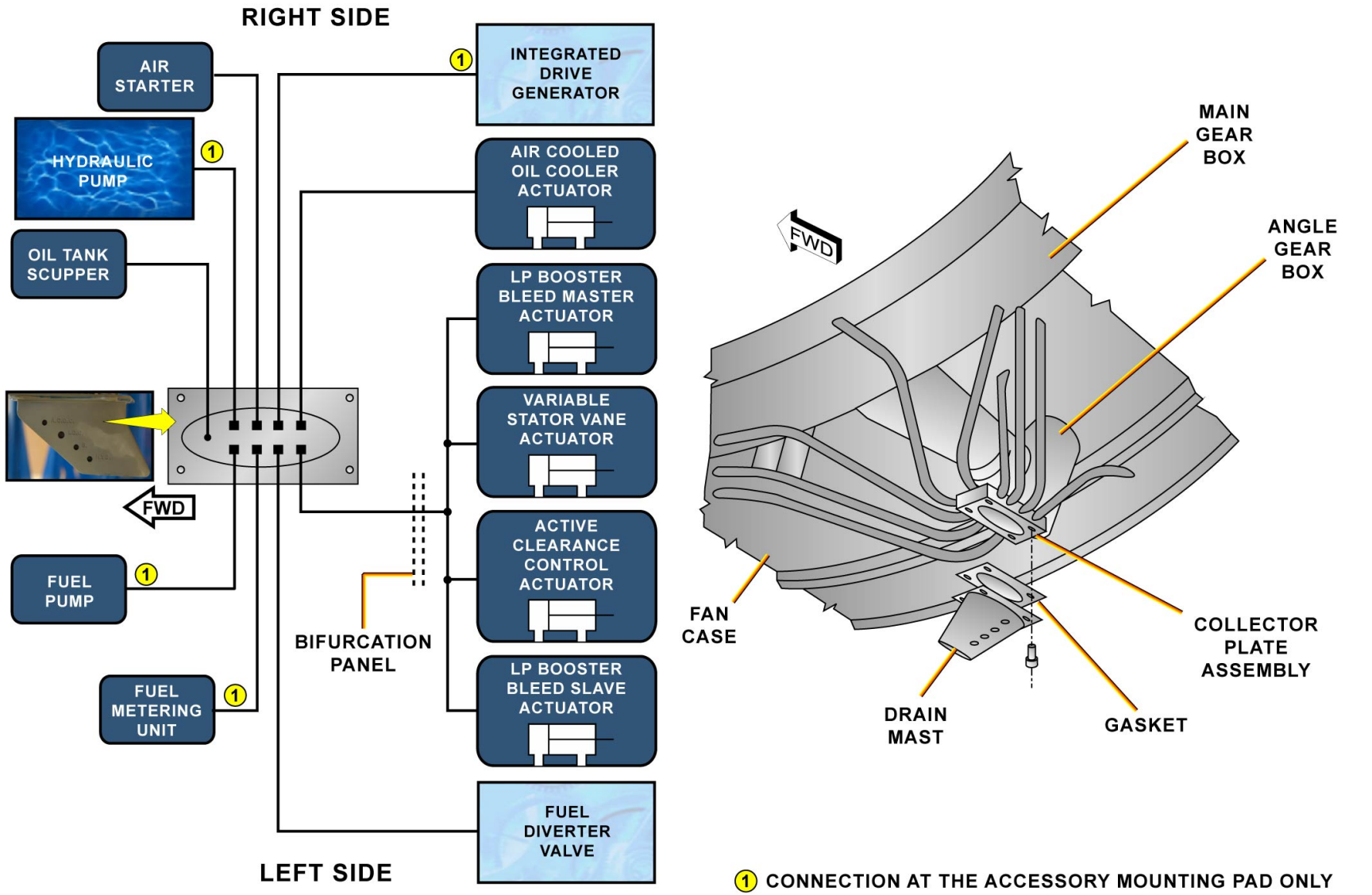

ENGINE DRAINS

POWER PLANT INSTALLATION D/O (3)

AIR INTAKE COWL

The air intake cowl is bolted onto the front of the fan case flange. It includes an anti-ice system, an interphone jack and a P2/ T2 probe.
For removal and installation, the components that follow supply the inlet cowl:
- 4 hoisting points,
- 36 identical attach fittings,
- 4 alignment dowels.

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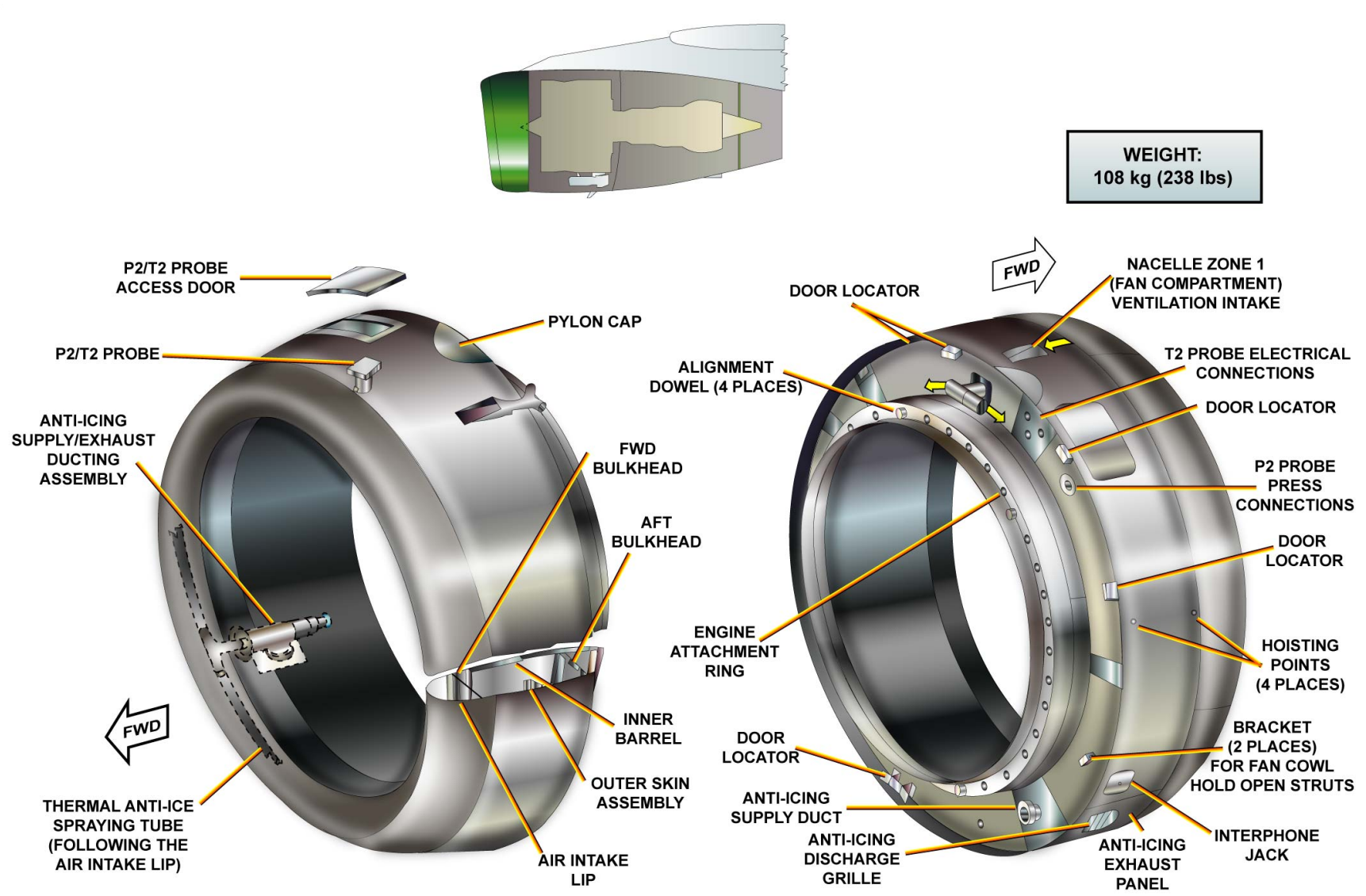

AIR INTAKE COWL

POWER PLANT INSTALLATION D/O (3)

FAN COWL DOORS (LH & RH)

There are two fan cowl doors to give access to the fan case and gearbox installed accessories.
Four hinges hold each door at the pylon. Four latches latch the door assembly along the bottom centerline.
Each door is installed with:
- 2 hoisting points, for removal and installation,
- 2 hold-open struts, to open.

Access doors are also installed for the start valve and to service the oil tank.

NOTE: Note that aerodynamic strakes are installed on the inboard nacelle side (A320).

As an option, the aerodynamic strakes can be installed at the outboard nacelle side.

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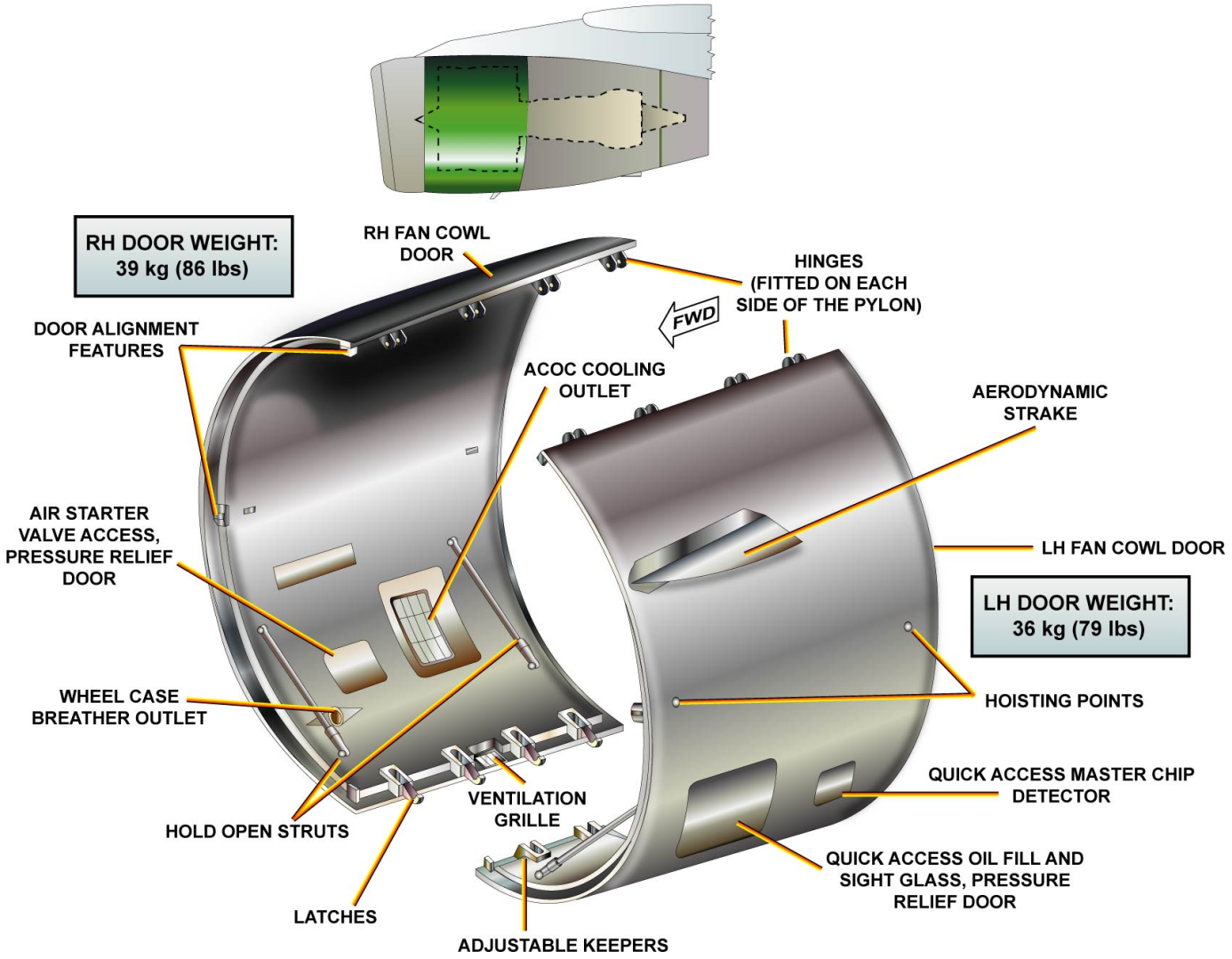

FAN COWL DOORS (LH & RH)

POWER PLANT INSTALLATION D/O (3)

THRUST REVERSER "C" DUCTS

The thrust reverser "C" ducts are in two halves installed with cascades, blocker doors and translating sleeves.
Four hinges hold each half at the pylon. 6 latches latch the halves assembly along the bottom centerline.
Each half is installed with:
- 3 attachment points for handling,
- 1 opening actuator operated with a hand pump,
- 2 hold-open rods for opening.

The latch assembly includes:
- 1 FWD bumper latch,
- 3 center latches, with access through a hinged access panel,
- 1 aft twin latch.

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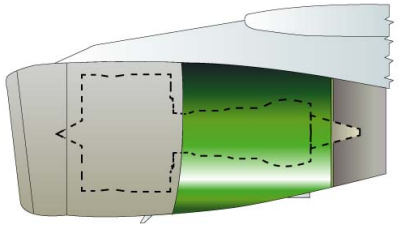

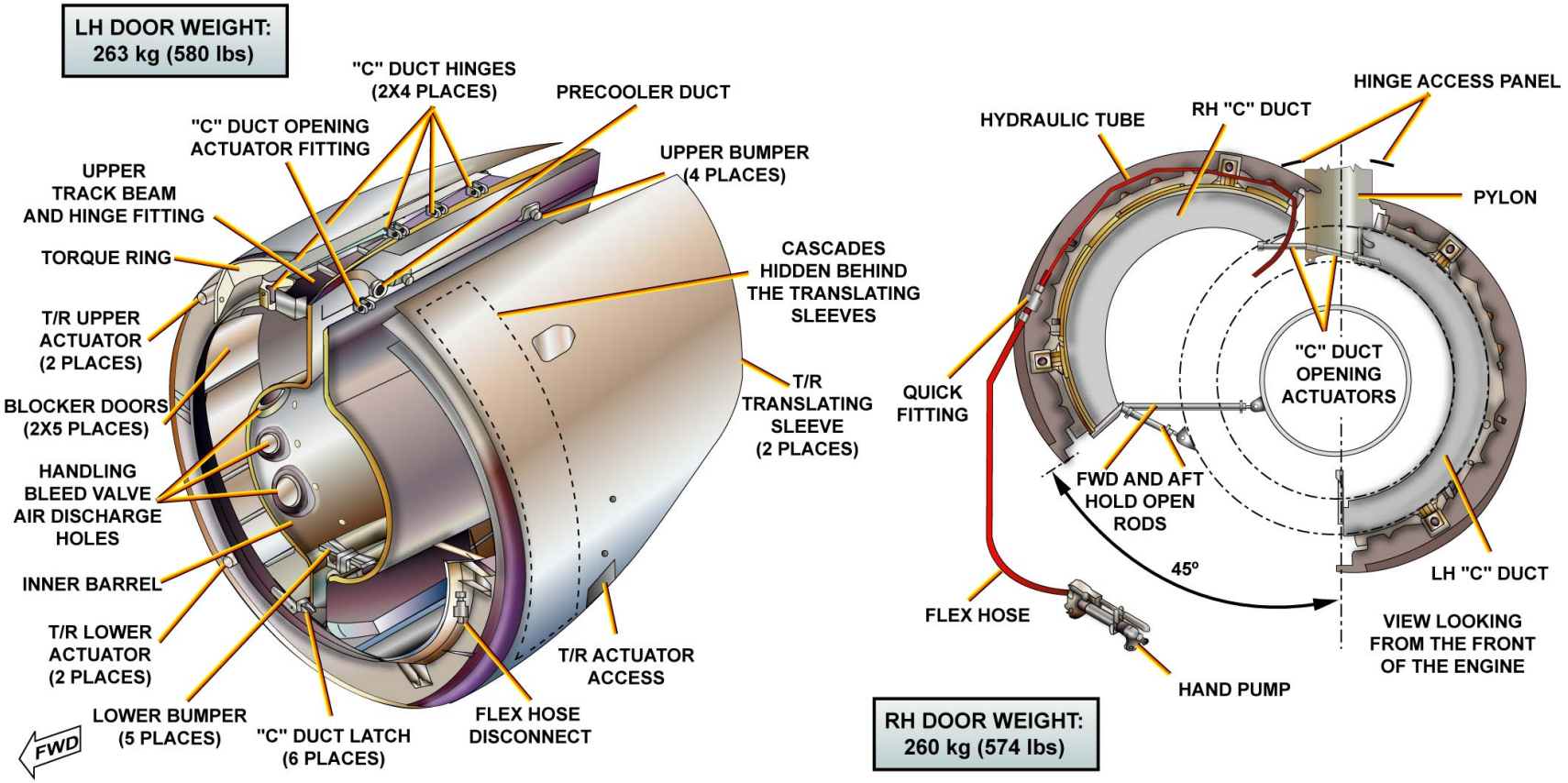

THRUST REVERSER "C" DUCTS

POWER PLANT INSTALLATION D/O (3)

FIREWALLS AND ACOUSTIC PANELS

The firewalls and fire seals protect from fire (to a fireproof standard) between the power plant designated fire zones. The fire seals divide the space in the engine into compartments. This means isolation limits propagation, if a fire occurs.
The aft bulkhead of the intake cowl and the rear of the inner barrel are made of carbon composite sandwich and the two supply a firewall barrier to the fan case compartment (zone 1).
The inner barrel in the air intake cowl is made of carbon fiber composite/Nomex honeycomb for acoustic purpose and is bolted to the engine fan casing front flange. The acoustic panels are structural and transmit air-intake cowl loads.
The mixed exhaust system structure has acoustic panels. The engine exhaust cone makes the inner contour of the common nozzle exhaust collector. This exhaust cone is made of a welded inco 625 honeycomb perforated panel for sound attenuation.
In the thrust reverser, the translating sleeves are also installed with acoustic panels. The acoustic panels are sandwich panels.

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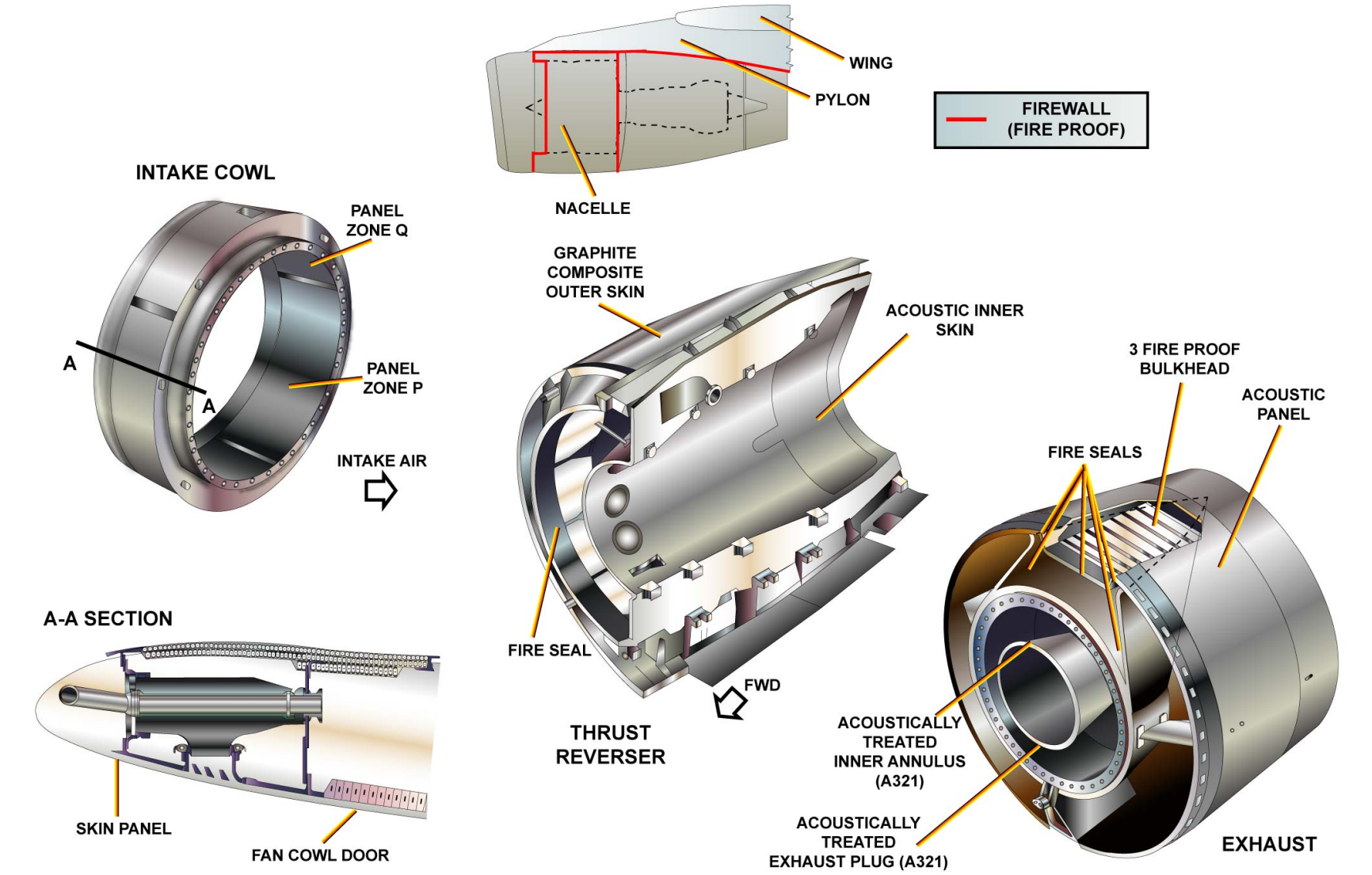

FIREWALLS AND ACOUSTIC PANELS

POWER PLANT INSTALLATION D/O (3)

COMMON NOZZLE ASSEMBLY

The Common Nozzle Assembly (CNA) mixes the exhaust gases from the secondary and primary airflows. It is bolted to the rear flange of the turbine exhaust case.
56 bolts attach the CNA to the LP turbine frame.

EXHAUST CONE

The exhaust cone supplies the inner contour of the common exhaust stream flow. It is attached to the inner flange of the turbine exhaust case.
13 bolts attach the exhaust cone to the inner LP turbine frame.

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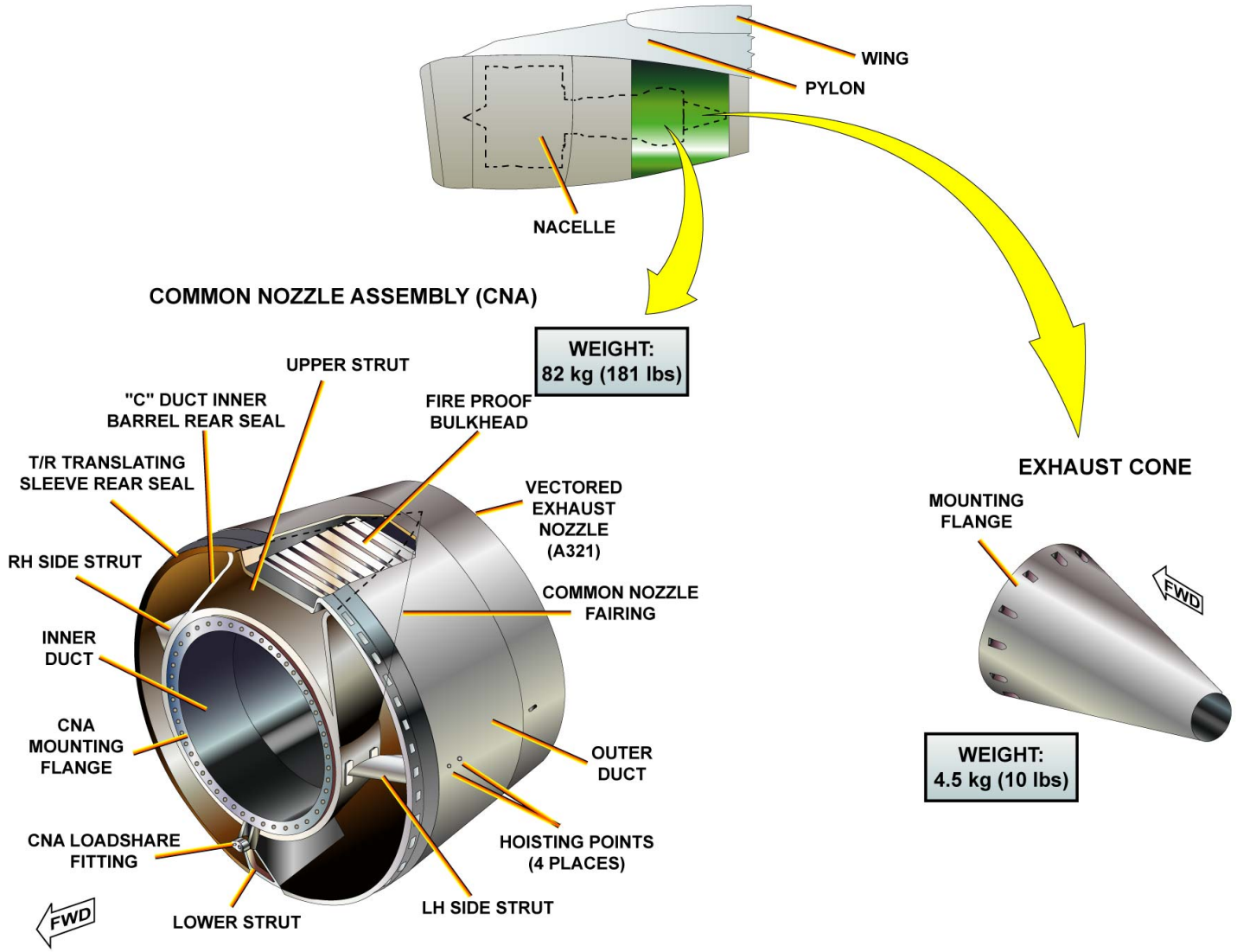

COMMON NOZZLE ASSEMBLY & EXHAUST CONE

POWER PLANT INSTALLATION D/O (3)

FWD MOUNT

The FWD mount transmits the engine thrust, vertical and side loads. It is installed on the intermediate case, at the top center of the LP compressor, with the FWD support shaft of the engine.
The FWD mount is made of 4 main parts:
- two thrust link assemblies,
- a beam assembly,
- a cross beam assembly,
- a support bearing assembly.

The FWD mount is made to be fail-safe. 4 bolts and self-locking nuts link it to the pylon FWD part.

AFT MOUNT

The aft mount transmits the engine torque, vertical and side loads. It is free in FWD and aft directions to let engine thermal expand.
It is installed on the case lugs of the turbine exhaust.
The aft mount is made of 3 main parts:
- a beam assembly,
- two side link assemblies,
- a center link assembly.

The aft mount is made to be fail-safe. 4 bolts link it to the pylon aft part.

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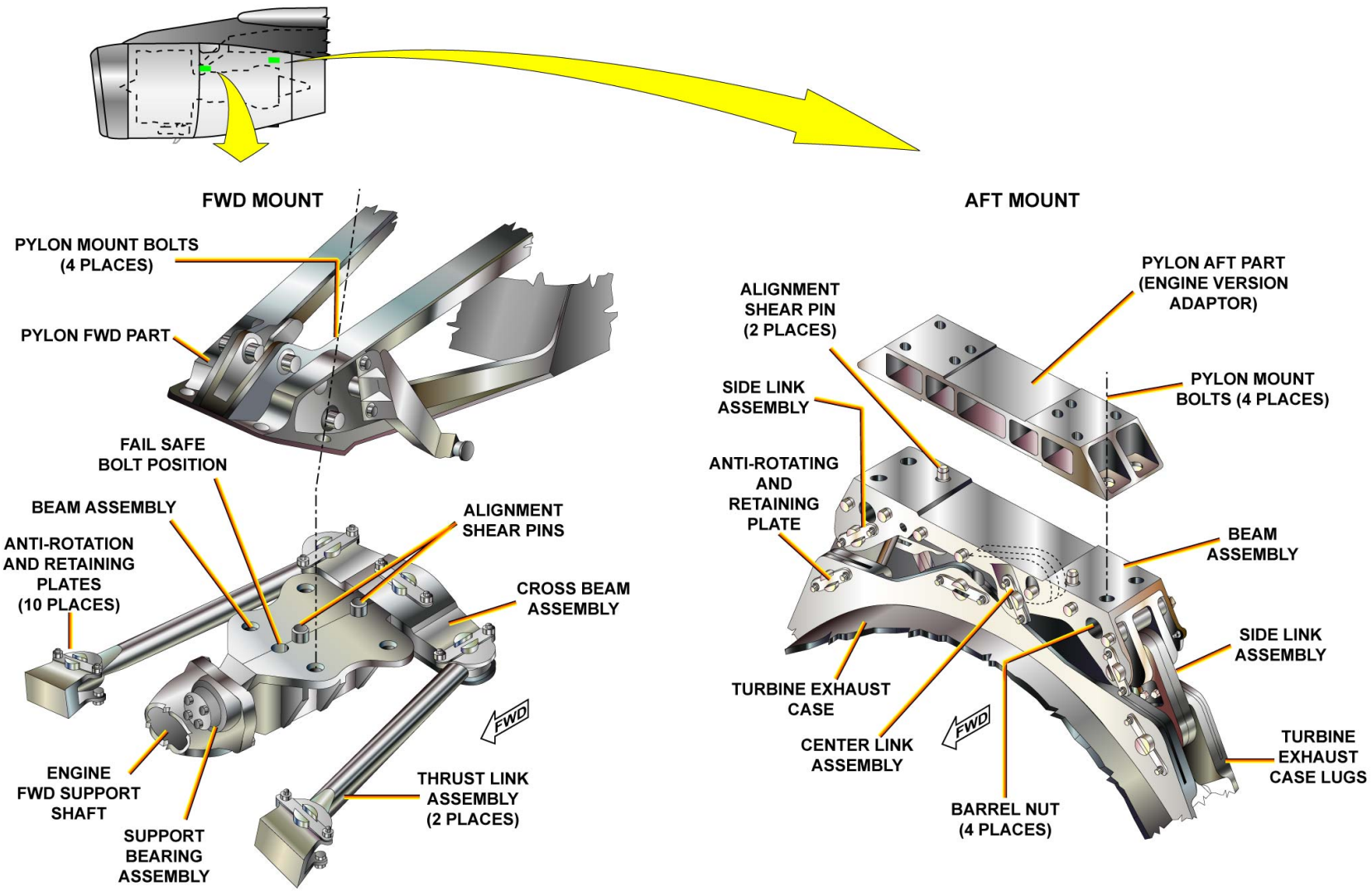

FWD MOUNT & AFT MOUNT

POWER PLANT INSTALLATION D/O (3)

FLUID DISCONNECT PANEL

The fluid disconnect panel supplies the fluid connection between engine and pylon. It is installed on the LH side of the fan-case upper part.
The fluid connection lines for the fuel system are:
- fuel supply,
- fuel return to tank.

The fluid connection lines for the hydraulic system are:
- hydraulic pump suction,
- hydraulic pump pressure delivery,
- hydraulic pump case drain.

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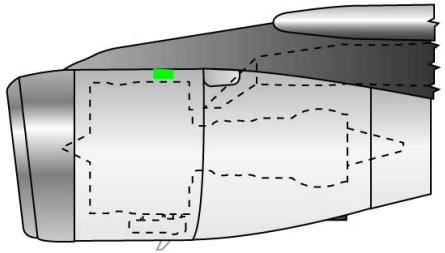

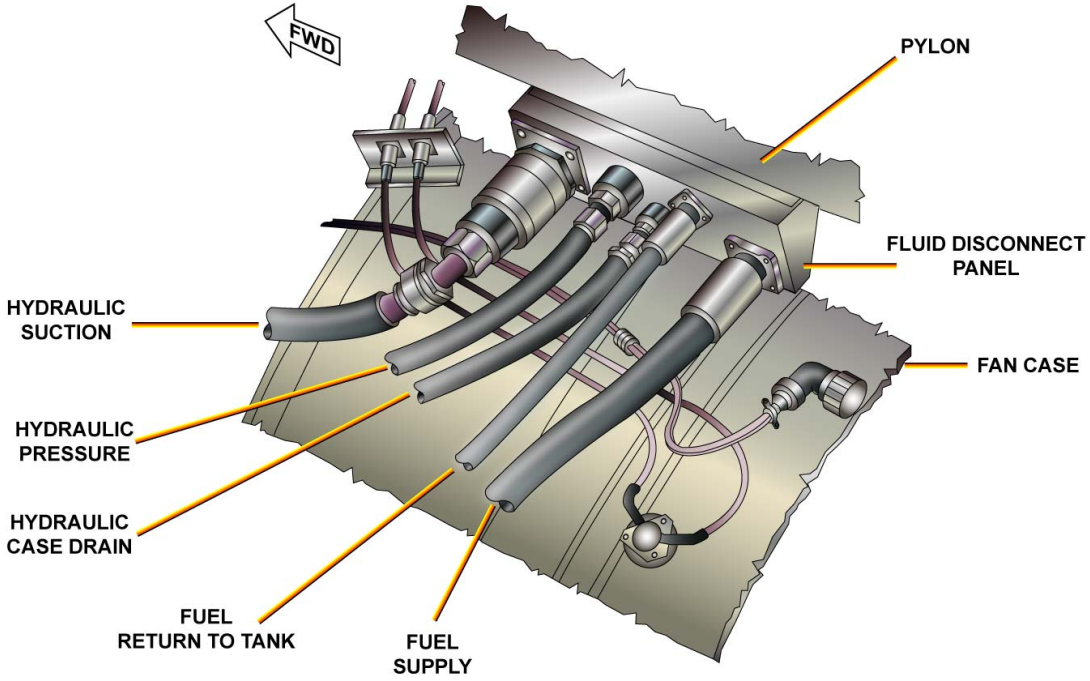

FLUID DISCONNECT PANEL

POWER PLANT INSTALLATION D/O (3)

FAN ELECTRICAL CONNECTOR PANEL

The fan electrical connector panel supplies the interface between the fan electrical harnesses and the pylon.
It is installed on the RH side of the fan-case upper part.

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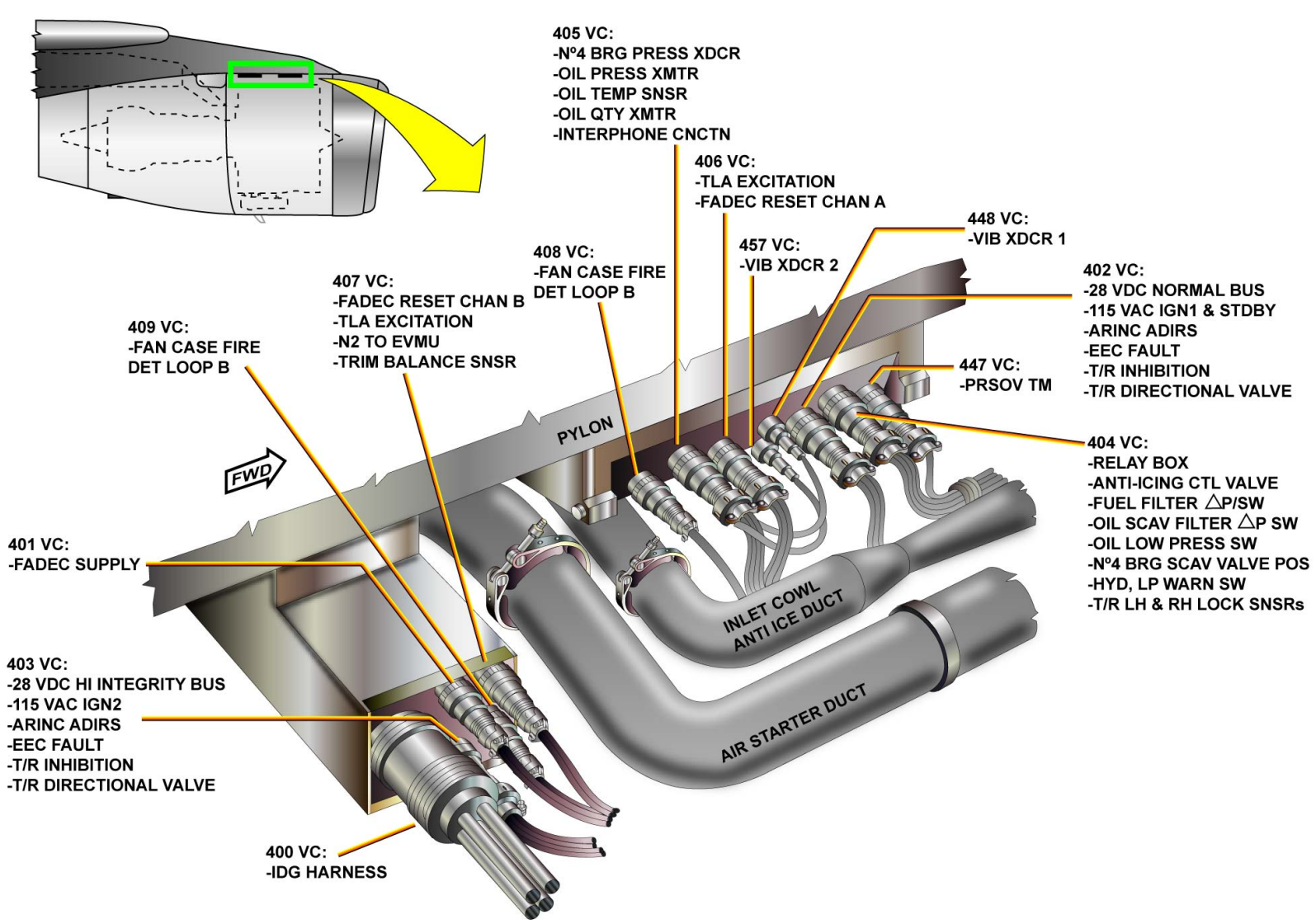

FAN ELECTRICAL CONNECTOR PANEL

POWER PLANT INSTALLATION D/O (3)

CORE ELECTRICAL JUNCTION BOX

The core electrical junction box supplies the interface between the core electrical harnesses and the pylon.
It is installed in the FWD mount zone.

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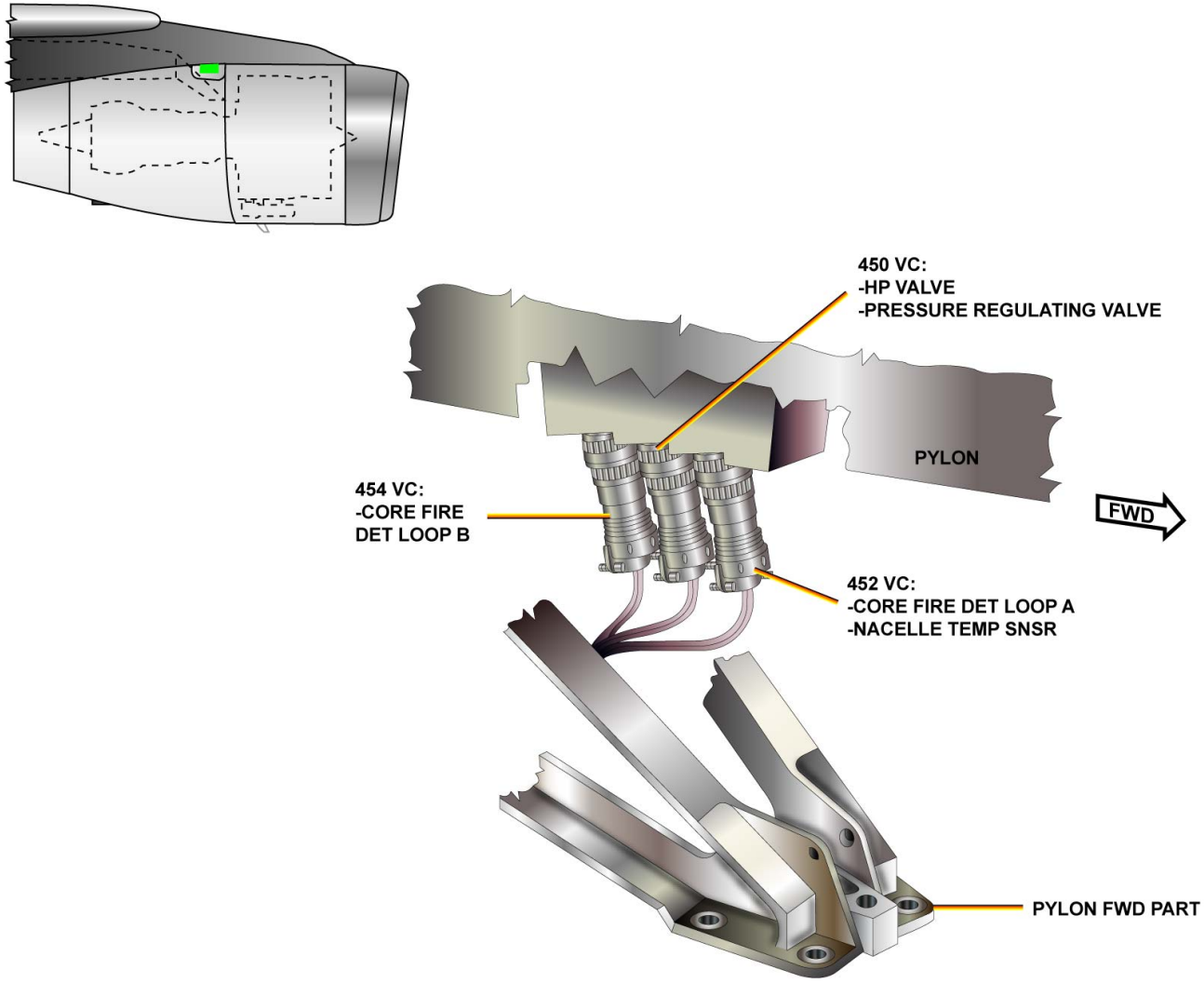

CORE ELECTRICAL JUNCTION BOX

POWER PLANT INSTALLATION D/O (3)

BOOTSTRAP SYSTEM INSTALLATION

The removal and installation of the engine requires the installation of a bootstrap system on the aircraft pylon. The bootstrap system is composed of two elements, to be installed at the front and at the rear of the pylon. Each element permits to attach at its ends the chain pulley blocks assembly and dynamometers that are used to lower or to lift the transportation stand attached to the engine.

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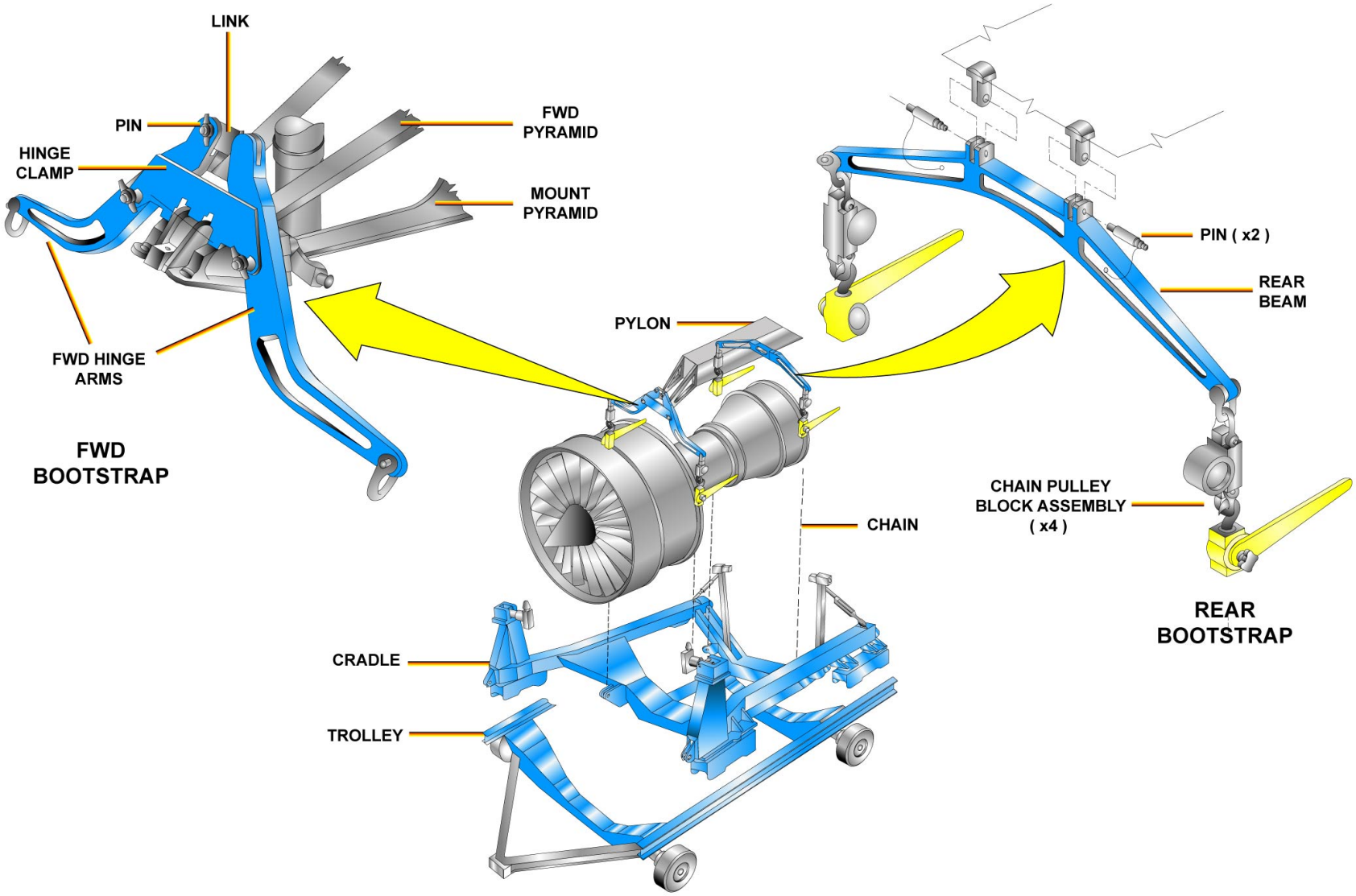
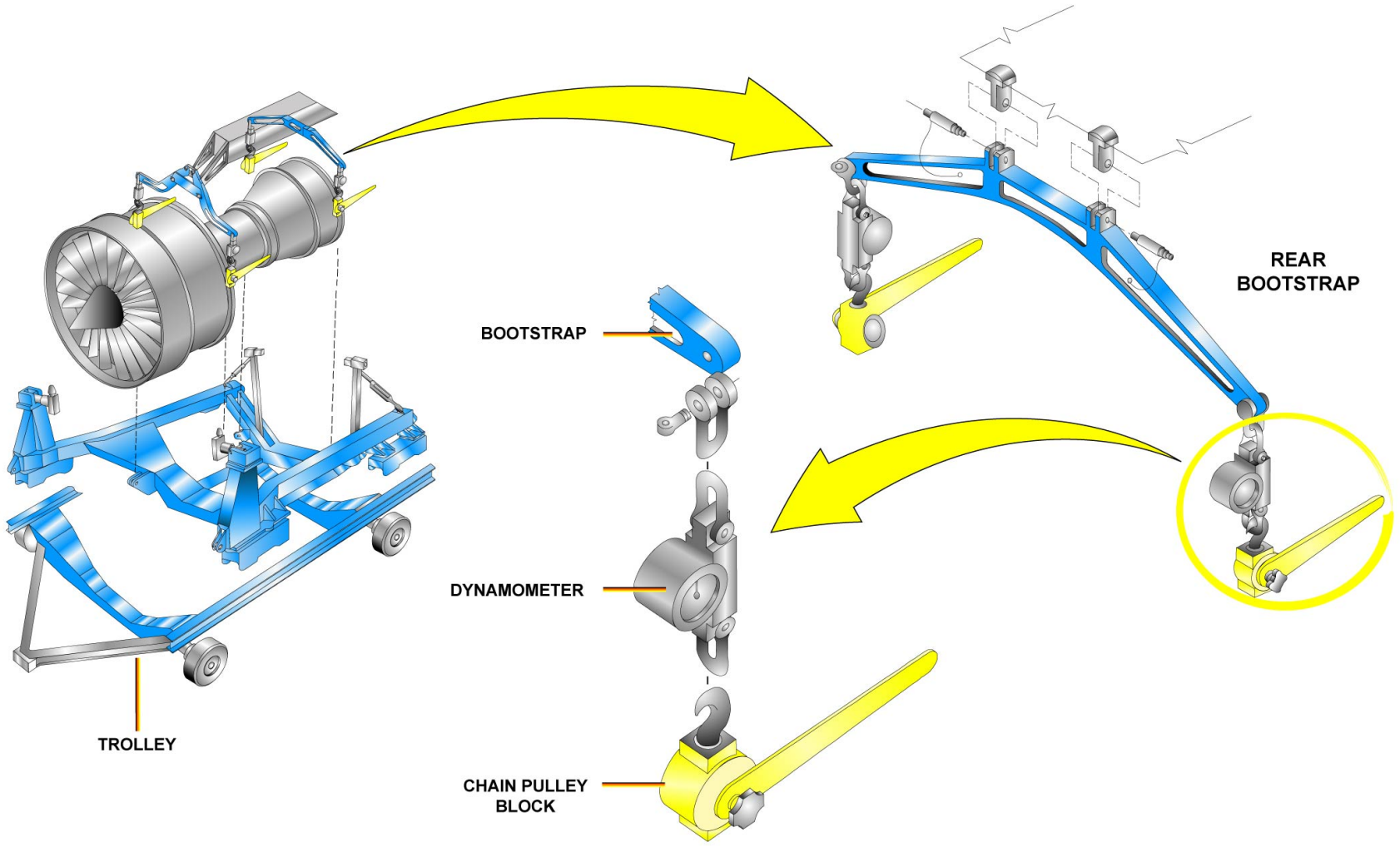


BOOTSTRAP SYSTEM INSTALLATION



BOOTSTRAP SYSTEM INSTALLATION

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POWER PLANT INSTALLATION D/O (3)

ENGINE TRANSPORTATION STAND ATTACHMENT POINTS

The engine transportation stand, which is used for engine removal and installation, can be fixed to the engine by means of four trunnions:
- two front trunnions fixed on the LP compressor case, LH side and RH side,
- two rear trunnions fixed on the LP turbine case, LH side and RH side.

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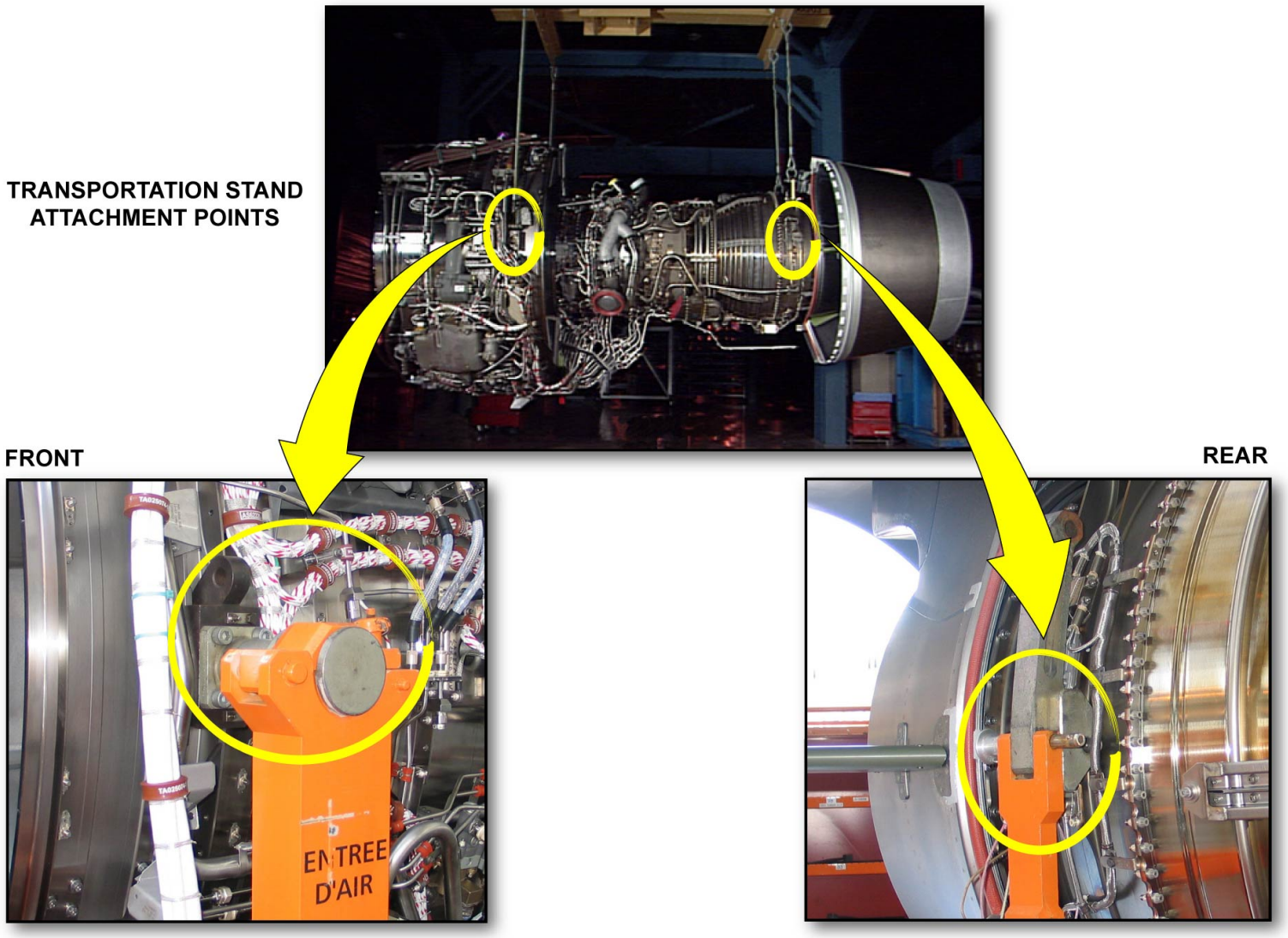

ENGINE TRANSPORTATION STAND ATTACHMENT POINTS

ENGINE SYSTEM D/O (3)

ENGINE CHARACTERISTICS

The Airbus A319/A320/A321 are powered by two International Aero Engines (IAE) V2500- A5 turbofan engines.
These engines can produce a thrust ranging from 22,000 lbs (9,980 kg) to 33,000 lbs (14,970 kg) depending on the aircraft version set by the engine data-programming plug.
SELECT ONE Technology includes increased cooling air on second stage HPT vane, new second stage HPT seal and new EEC hardware.

PYLON

The engines are attached to the lower surface of the wings by pylons. The pylons supply an interface between the engine and the aircraft for electrics and fluids.

NACELLE

The engine is enclosed in the nacelle, which supplies aerodynamic airflow around the engine and ensures protection for the accessories.

ENGINE CONTROL

The engine includes a Full Authority Digital Engine Control (FADEC), which supplies engine control, engine monitoring and help for maintenance and trouble shooting.

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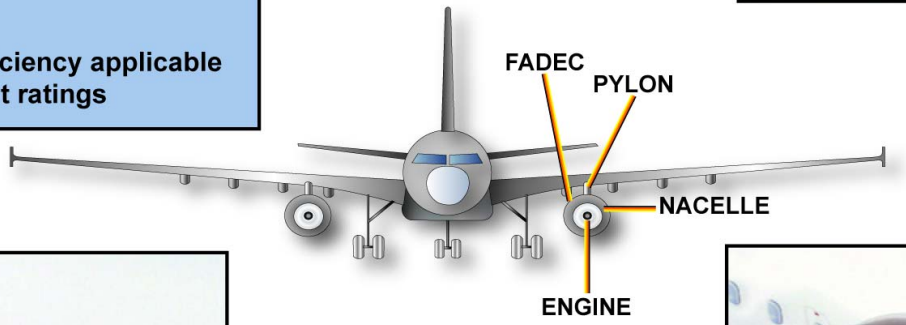
ENGINE DESIGNATION	THRUST RATING	AIRCRAFT TYPE
V2522-A5	22000 lbs (9980 kg)	A319
V2524-A5	24000 lbs (10890 kg)	A319
V2524E-A5	24000E lbs (10890 kg)	A319
V2527-A5	27000 lbs (12250 kg)	A320
V2527E-A5	27000E lbs (12250 kg)	A320
V2527M-A5	27000M lbs (12250 kg)	A319
V2530-A5	31400 lbs (14240 kg)	A321
V2533-A5	33000 lbs (13610 kg)	A321

SELECT ONE Technology

V25xx-A5 SQ03: Higher efficiency applicable to all thrust ratings



ENGINE CHARACTERISTICS - PYLON ... ENGINE CONTROL

ENGINE SYSTEM D/O (3)

ENGINE GENERAL PARAMETERS

There is a different kind of thrust depending on the engine installed on the aircraft. For the A319, 22,000 lbs (9,980 kg) can be achieved during take off conditions with the V2522-A5, and 24,000 lbs (10,890 kg) with V2524-A5 version.
For the A320, 27,000 lbs (12,250 kg) can be achieved during take off conditions with the V2527-A5 version.
For the A321, 31,400 lbs (14,240 kg) can be achieved during take off conditions with the V2530-A5 and 33,000 lbs (14,970 kg) with the V2533-A5 version.
Other general parameters of the power plant are shown in the table too.

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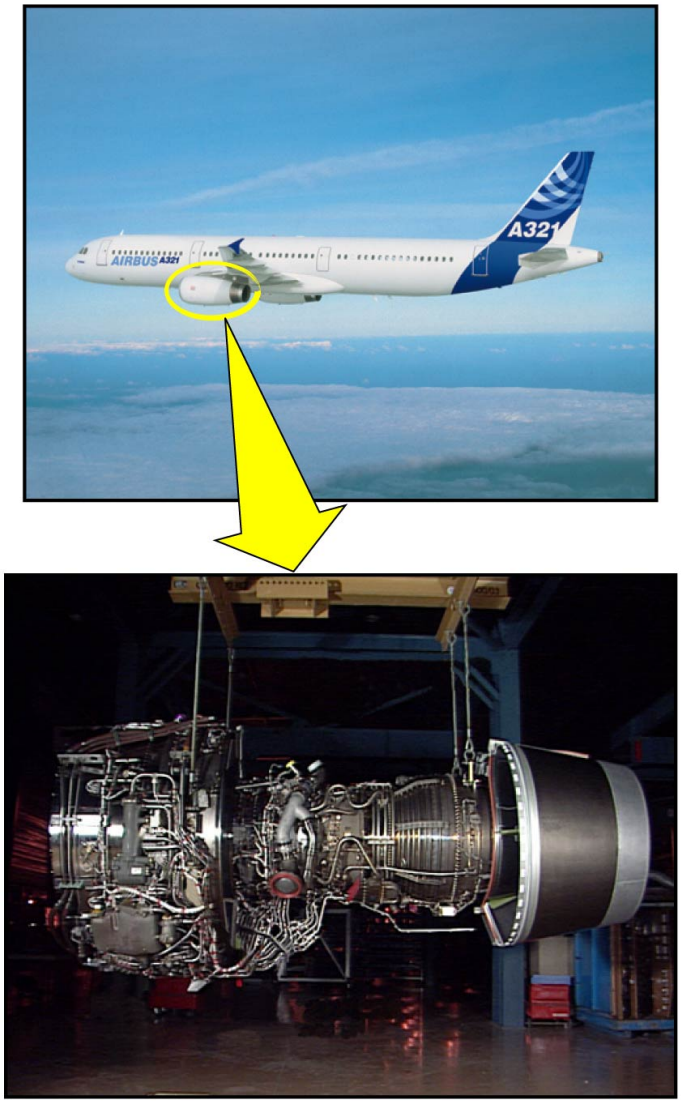
ENGINE PARAMETERS			
	A319	A320	A321
	SPECIFICATIONS		
Take-off thrust (lb)	22,000 / 24,000	27,000	31,400/33,000
(kg)	(9,980 / 10,890)	(12,250)	(14,240 / 14,970)
Flat rate temp. (C)	55	45	30
(F)	(131)	(113)	(86)
Fan diameter (In)	63.5	63.5	63.5
Air flow (lb/s)	770 / 781	811	858 / 872
(kg/s)	(349 / 354)	(368)	(389 / 396)
Bypass ratio	4.9	4.8	4.6 / 4.5
Climb-pressure ratio	32.8	32.8	35.2
Cruise sf (lbf/lb/hr)	0.543	0.543	0.543
Powerplant wt. (lb)	7500	7500	7500
(kg)	(3402)	(3402)	(3402)



ENGINE GENERAL PARAMETERS

ENGINE SYSTEM D/O (3)

ENGINE BEARINGS

The No.1, 2 and 3 (front) bearing compartment is built into the case module and contains the support bearings for the low spool and high spool stubshafts.
The No.4 bearing compartment is part of the diffuser/combustor module and the No 5 is located on the exhaust case.

NO.1 AND NO.2 BEARINGS

The No.1 ball bearing carries the axial loads generated by the LP rotor system. This bearing is a split inner race ball bearing. The No.1 bearing support provides structural support for the No.1 bearing, oil supply tube and No.1 bearing seal support.
The No.2 bearing is a cylindrical roller bearing with a shouldered outer race. The No.2 roller bearing carries the radial loads generated by the front part of the LP rotor system.

NO.3 BEARING

The No.3 ball bearing, internal gearbox and support assembly are located in the internal gearbox and drive section of the Low Pressure Compressor (LPC) intermediate case module. The No.3 ball bearing carries the axial loads generated by the HP rotor system.

NO.4 AND NO.5 BEARINGS

The No.4 bearing is a roller bearing, which is secured onto the bearing support assembly. Rotor support is transmitted through the bearing and bearing support to the diffuser case inner wall. The No.4 roller bearing carries the radial loads generated by the HP rotor system.
The Low Pressure Turbine (LPT) shaft is supported at the rear end by the No.5 roller bearing, which is located on the exhaust case. The No.5 bearing inner race is secured on the shaft by an interference fit and is secured against the seal assembly by a coupling nut. The outer race is loosely fitted in the bore of the bearing support.

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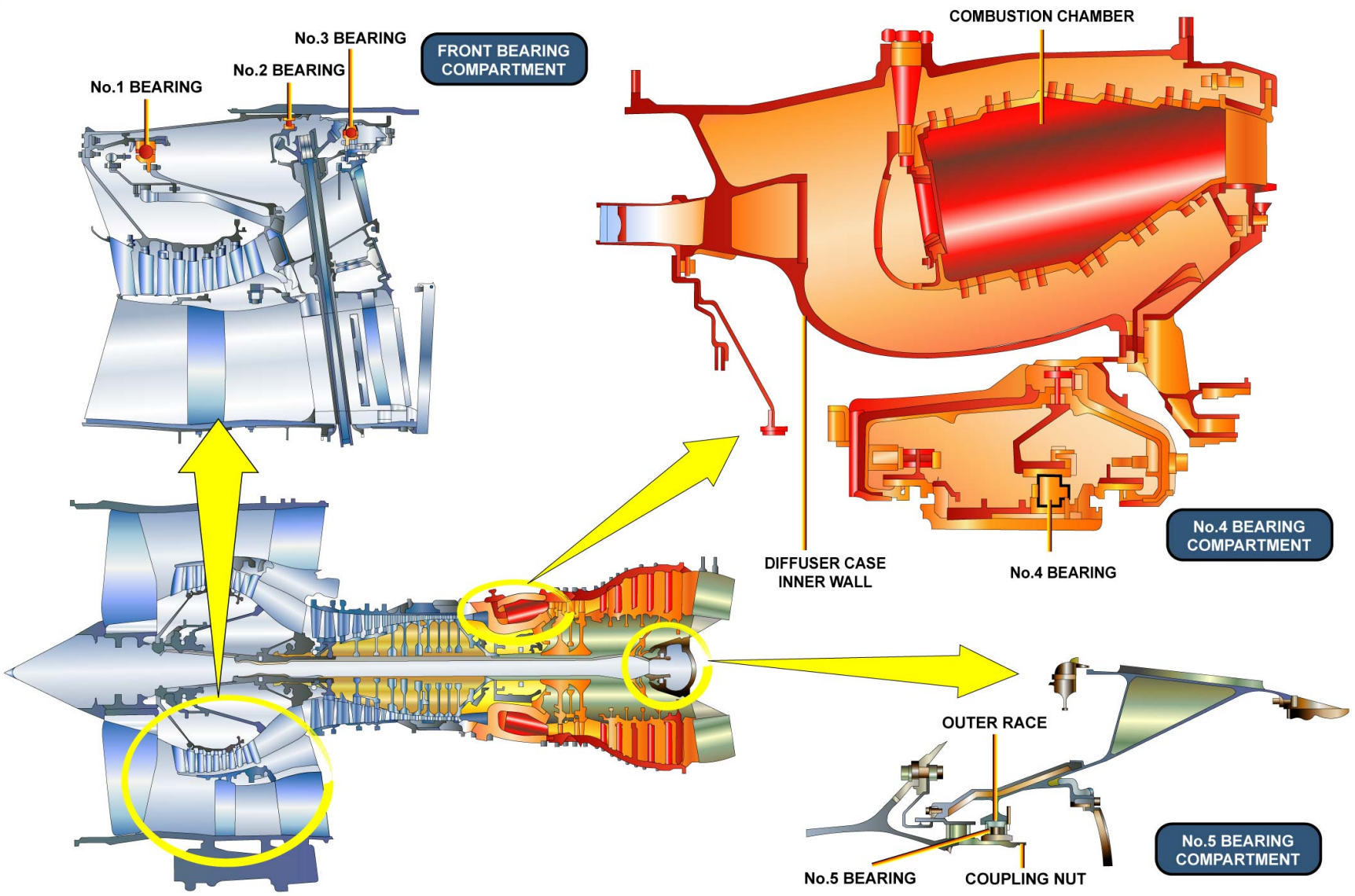

ENGINE BEARINGS - NO.1 AND NO.2 BEARINGS ... NO.4 AND NO.5 BEARINGS

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ENGINE SYSTEM D/O (3)

ENGINE SEALS

The most important seals in this engine are:
- front bearing compartment seals,
- diffuser case and combustor assembly seal.
- stage 1 High Pressure Turbine (HPT) air seals (inner and outer).
- stage 2 HPT air seal,
- LPT seals.

FRONT BEARING COMPARTMENT SEALS

The sealing of the compartment is done by the following components:
- No.1 bearing front carbon oil seal,
- hydraulic seal assembly for center seal,
- bearing compartment rear brush air seal,
- and No.3 bearing rear carbon oil seal.

DIFFUSER CASE AND COMBUSTOR SEALS

A double seal including a brush and knife edge seals is bolted onto the front inner diameter of the case. The seals prevent leakage of HPC discharge air into the diffuser case.
A seal is supplied at the transition from the rear of the combustor outer liner to the turbine nozzle guide vanes. The front lip of the combustor inner liner makes a seal with the inner diameter of the combustor hood.

STAGE 1 HPT AIR SEALS

In the stage 1 turbine rotor assembly, the blades fit into axial slots in the hub and are held in place at the front by the stage 1 air seal (outer). The stage 1 HPT air seal (inner) is located at the front of the stage 1 turbine hub. The stage 1 HPT inner and outer air seals control leakage of stage 1 HPT blade cooling air from the cooling duct.

STAGE 2 HPT AIR SEALS

The stage 2 HPT air seal is located between the stage 1 and 2 turbine rotor assemblies. The stage 2 air seal also acts as a spacer for proper axial positioning of both rotors.
In order to avoid HPT air seal cracking, a modification is made to increase cooling air and to reduce leakage on the 2nd stage vane for IAE V2500-A5 engines.

LPT SEALS

The outer static stages 3, 4, 5 and 7 rotor seals are separated seal segments with braze in honeycombs installed in the LPT case.
The bearing No. 5 compartment is sealed from the LPT cavity air by two element radial carbon seals. The carbon elements are contained in a housing assembly and sealed against the No. 5 bearing compartment outer wall and the seal housing walls.

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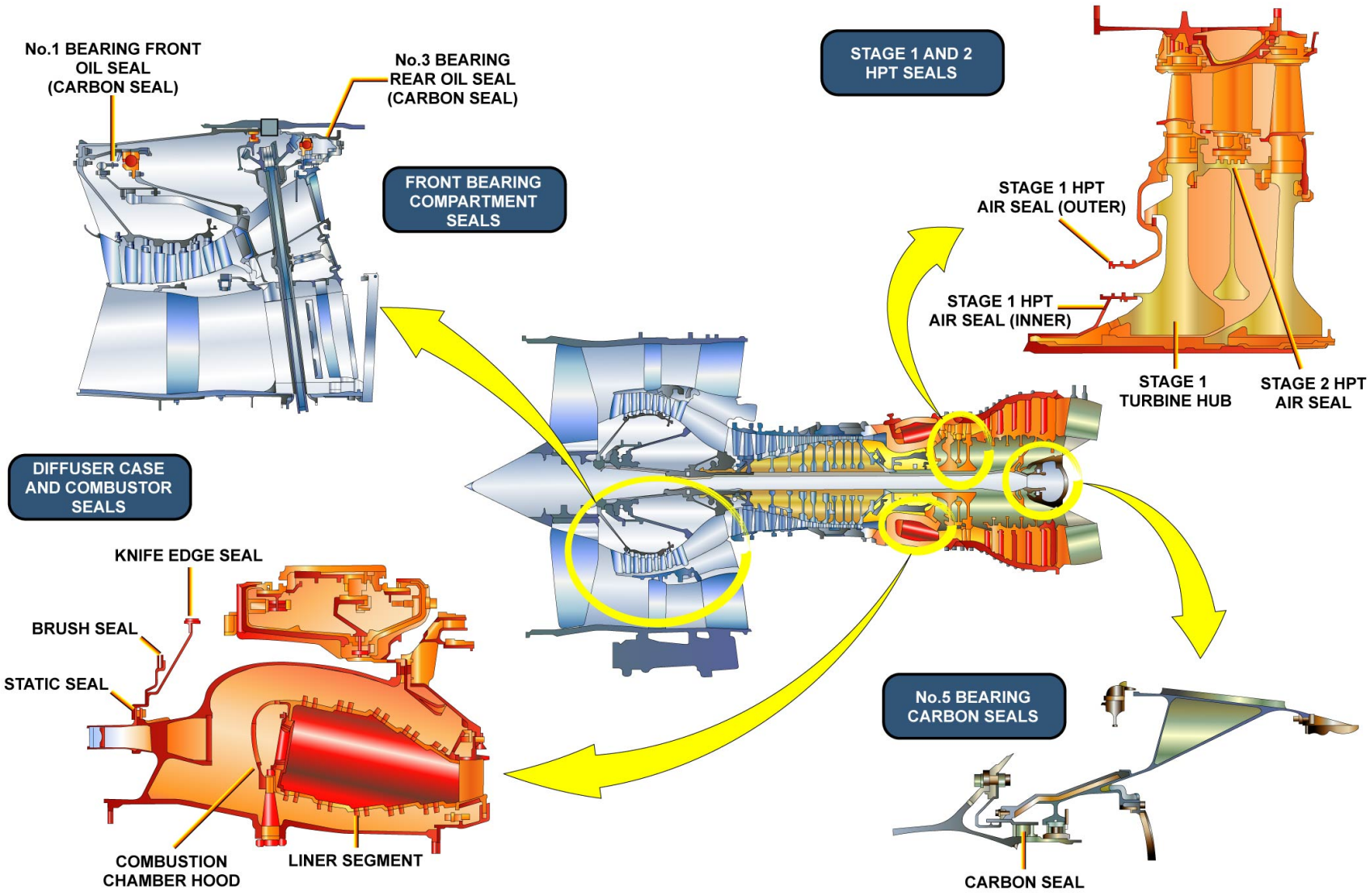
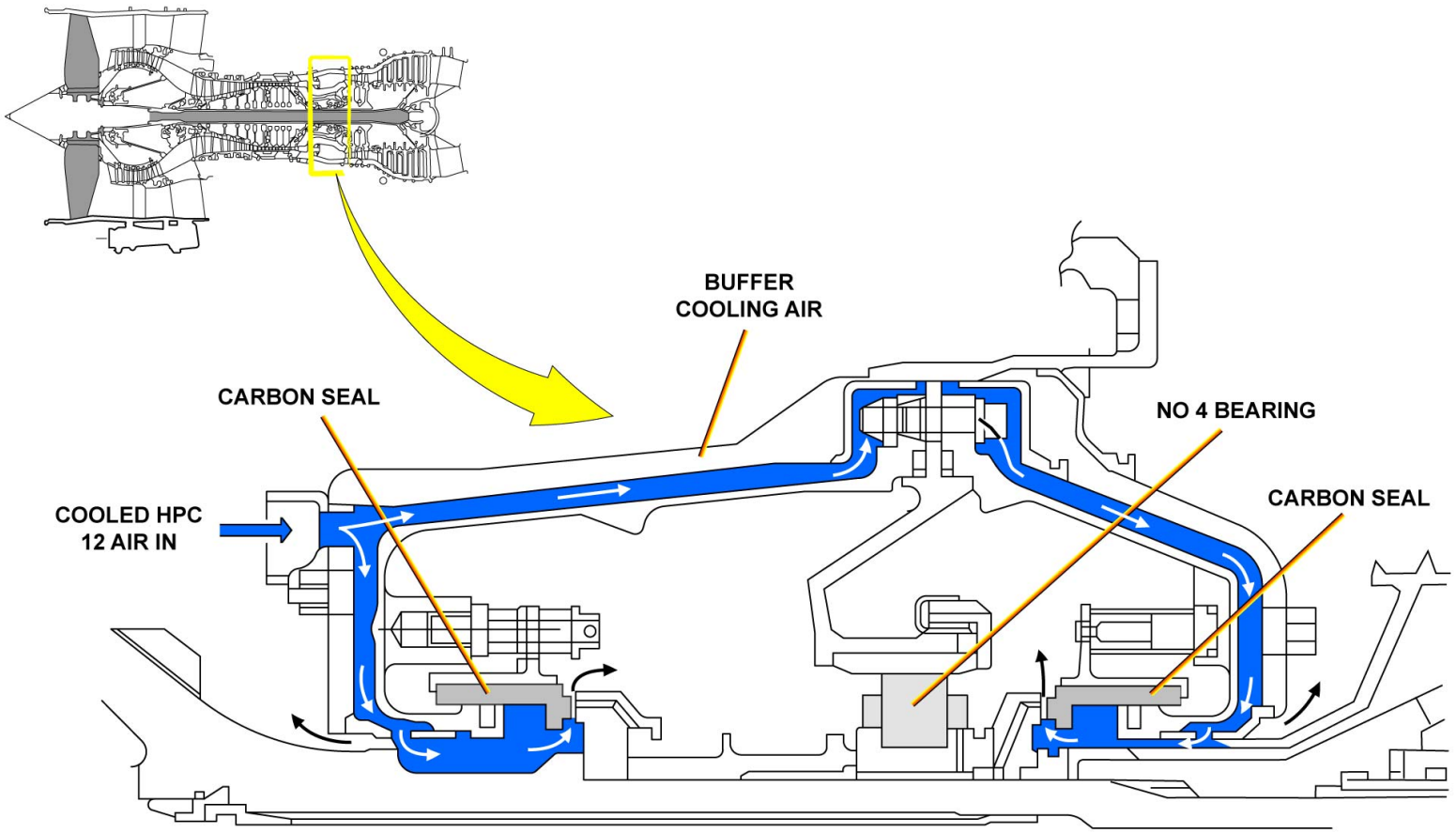

No.1 BEARING FRONT OIL SEAL (CARBON SEAL)
No.3 BEARING REAR OIL SEAL (CARBON SEAL)
FRONT BEARING COMPARTMENT SEALS
STAGE 1 AND 2 HPT SEALS
STAGE 1 HPT AIR SEAL (OUTER)
STAGE 1 HPT AIR SEAL (INNER)
STAGE 1 TURBINE HUB
STAGE 2 HPT AIR SEAL
DIFFUSER CASE AND COMBUSTOR SEALS
KNIFE EDGE SEAL
BRUSH SEAL
STATIC SEAL
COMBUSTION CHAMBER HOOD
LINER SEGMENT
No.5 BEARING CARBON SEALS
CARBON SEAL

ENGINE SEALS - FRONT BEARING COMPARTMENT SEALS ... LPT SEALS

ENGINE SYSTEM D/O (3)

OIL COMPARTMENT SEALING

Oil Compartment sealing is achieved by using pressurized air, also called buffer air. This air, coming from different compressor stages, is directed in front of the carbon seals to make sure, that only air can enter the bearing compartment but not oil can leave the bearing compartment. This is achieved by making sure, that the buffer air pressure is higher than the pressure in the bearing compartment.
The air / oil mixture goes back into the oil system by the scavenge pump system.



NO 4 BEARING COMPARTMENT

OIL COMPARTMENT SEALING

ENGINE SYSTEM D/O (3)

COMPRESSOR

The compressor section includes three modules:
- LPC (fan) module assembly,
- LPC/intermediate case module,
- HPC module.

LPC FAN MODULE ASSEMBLY

The LPC (fan) module is a rotor assembly, which includes twenty-two blades and a disk. Rotation of the rotor causes air to be ingested into the front of the engine and compressed.
A large proportion of the compressed air is delivered through the fan discharge duct to the exhaust nozzle to supply the majority of engine thrust. The remainder of the compressed air goes into the booster section for further compression by the booster.

LPC INTERMEDIATE CASE MODULE

The LPC intermediate case module includes a four stages axial flow booster section, a fan case section and an internal gearbox and drive section.
The fan case section of LPC/intermediate case module makes the outer annulus of the cold stream duct.

HPC

The HPC is a ten stages axial flow module. It comprises the HPC, blades, the front casing and variable vanes, the rear casing which contains the fixed stators and shapes the bleed manifolds.

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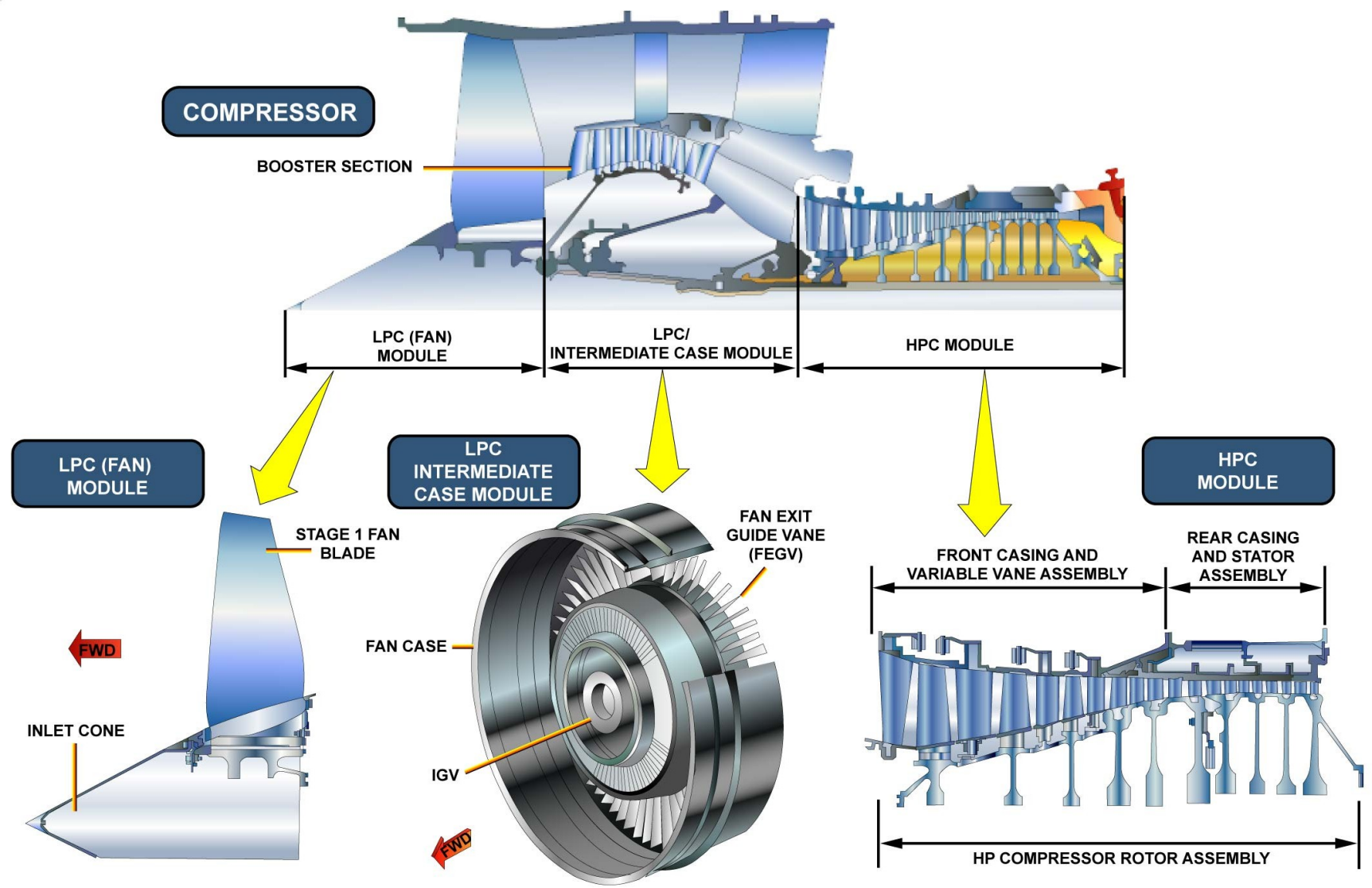

COMPRESSOR - LPC FAN MODULE ASSEMBLY ... HPC

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ENGINE SYSTEM D/O (3)

COMPRESSOR OPERATION

Rotation of the fan rotor causes air to be ingested into the front of the engine and to be compressed. Compressed air is then divided into two separate airflows:
- a large portion is delivered to the exhaust nozzle,
- the remainder is compressed in the booster before being compressed again by the HPC.

The fan outlet inner vane assembly, compressor stage 1.5, 2, 2.3 and 2.5 assemblies and compressor stage 2.5 vanes compress the air progressively. Then the air is delivered at a suitable pressure to the HPC. Then the HPC accepts air from the LPC and booster system, further compress it, and direct the air to the diffuser/combustion.

LPC bleed valve and actuating mechanism are incorporated into the bleed air system The modulated bleed makes sure that the booster has an adequate surge margin under all operating conditions.

Due to the compression ratio that supports each stage, the airflow tries to expand in counter direction. If the entire compressor is not capable to compress the airflow.

Stall is a local effect where the airflow is not compressed. Stall effects can bring the compressor to surge. To prevent the compressor surge the stall effects are controlled through the methods of airflow control.

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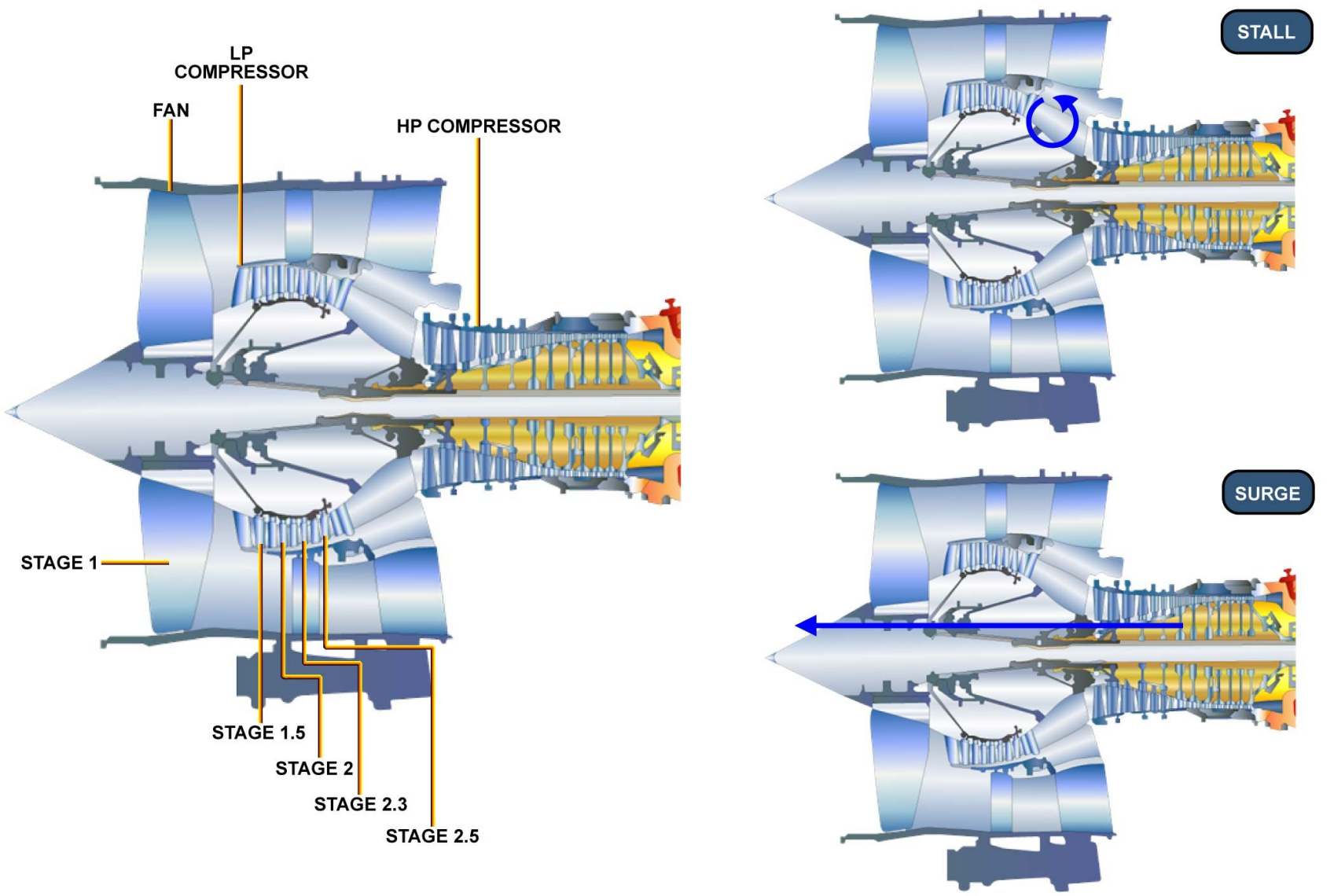

COMPRESSOR OPERATION

ENGINE SYSTEM D/O (3)

COMBUSTION SECTION

The diameter of the diffuser section is larger at the rear than at the front. This diametral difference decreases the speed of the air and changes the energy of the speed into pressure.
The combustion section includes primarily the diffuser case, combustor, fuel injector and igniters. The high compressor exit guide vanes, the turbine nozzle assembly and the No.4 bearing compartment are also part of the module.
The diffuser case has twenty mounting pads, where the fuel injectors are installed and two mounting pads where the igniter plugs are installed and six borescope bosses located around the case.
The combustor is an annular type combustor, which includes an outer liner assembly and an inner liner assembly.

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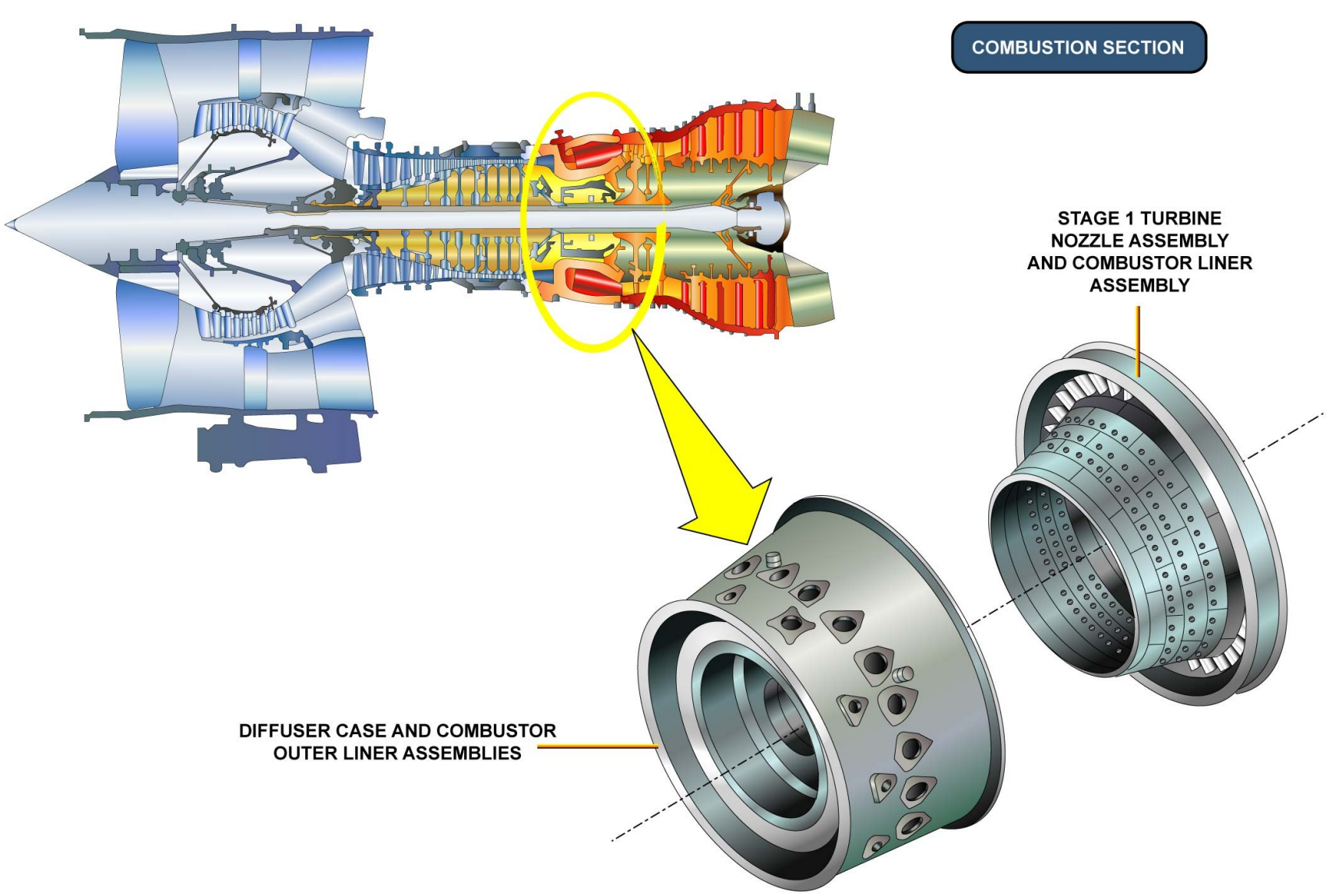

COMBUSTION SECTION

ENGINE SYSTEM D/O (3)

COMBUSTION SECTION OPERATION

The combustion section has four primary functions:
- straighten the flow of air from the HPC,
- change the flow of air characteristics to get the best speed and pressure for combustion,
- mix fuel with the air and supply ignition to make the fuel burn,
- hold the No.4 bearing in position.

In the combustion section the gases increase their energy with a controlled combustion process. These gases release their energy to the turbine nozzles driving the engine rotors.

The air is guided and diffused around the combustor through the diffuser case inner and outer walls. Air, which surrounds the combustor, is used in the combustion process for dilution and in exit temperature profile control of the combustion gases and for the cooling of the combustor walls.

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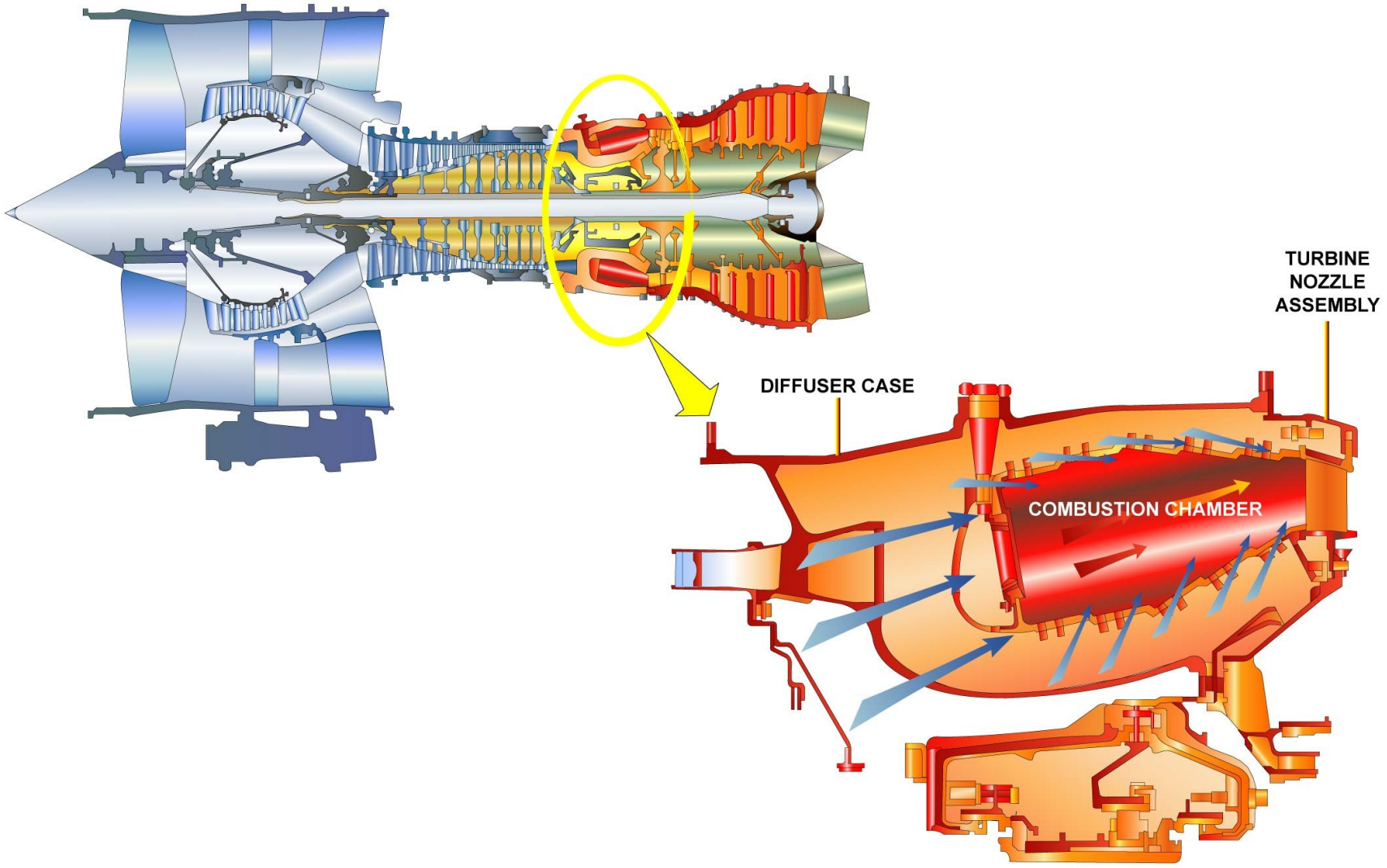

COMBUSTION SECTION OPERATION

ENGINE SYSTEM D/O (3)

TURBINE SECTION

The turbine section includes the HPT and LPT modules.
The HPT is a two stages turbine and drives the HPC and the accessory gearbox.
The LPT is a five stages module attached at the rear flange of the HPT module.
Active Clearance Control (ACC) is used to control seal clearances and to supply structural cooling.

HPT SECTION

The HPT rotor and stator assembly includes stage 1 turbine rotor assembly; a HPT case and vane assembly; a stage 2 HPT airseal; and a stage 2 turbine rotor assembly.

LPT CASE, VANES AND STATIC SEALS

The LPT case, stator vanes and seals are the static parts of the LPT assembly. This assembly includes five stages of vanes, static air seals, and diffuser of inner and outer segments assembled in a casing.

LPT ROTOR

The LPT rotor is a bolted configuration including five disks and associated blades and rotating air seals.

LPT SHAFT

The LPT Shaft joins the LPT assembly with the LPC and the Fan. The shaft is bolted to the LPT at the LPT rotor disk stage 6 and extends forward through the engine.

TEC AND Nº5 BEARING ASSEMBLY

The Turbine Exhaust Case (TEC) is used to straighten the turbine exhaust gases, and supplies structural support for the No.5 bearing.

ACTIVE CLEARANCE CONTROL SYSTEM (ACC)

The ACC system uses air to control the tip clearances of the HPT and LPT blades.

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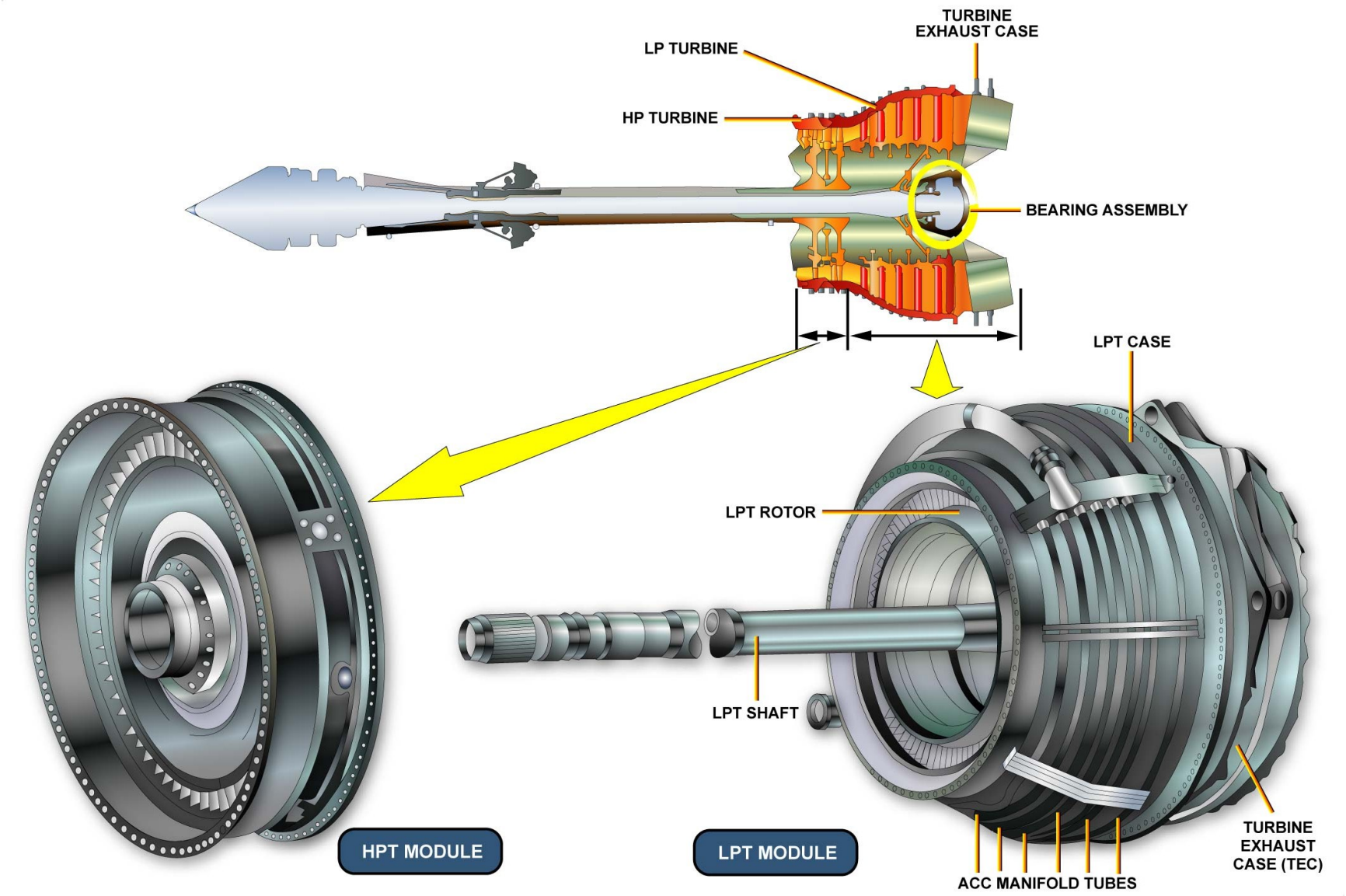

TURBINE SECTION - HPT SECTION ... ACTIVE CLEARANCE CONTROL SYSTEM (ACC)

ENGINE SYSTEM D/O (3)

TURBINE SECTION OPERATION

The HPT rotor and stator assembly supplies the rotational driving force to the HPC and accessory gearbox by extracting energy from the hot combustion gases, and releases a gas stream to the LPT in order to drive the LPC and the fan through the LPT shaft.
Exhaust gas from the LPT goes through a nozzle to supply propulsive thrust.
Blade tip clearance and LPT case heat expansion are controlled by an external ACC system. Fan discharge air is directed externally to the LPT case via the ACC tubes. This controls the heat expansion of the LPT case and optimizes the blade tip clearances.

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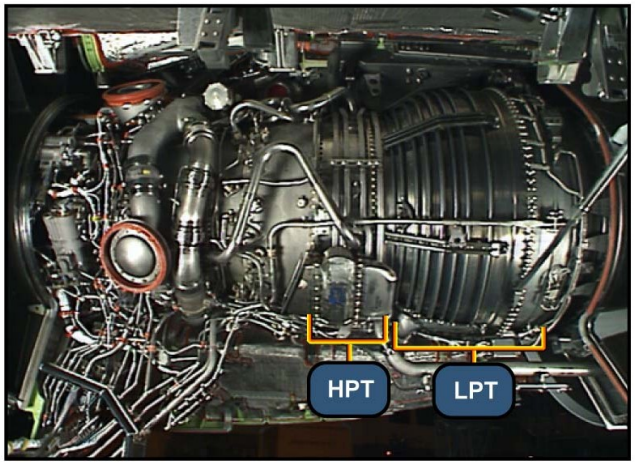

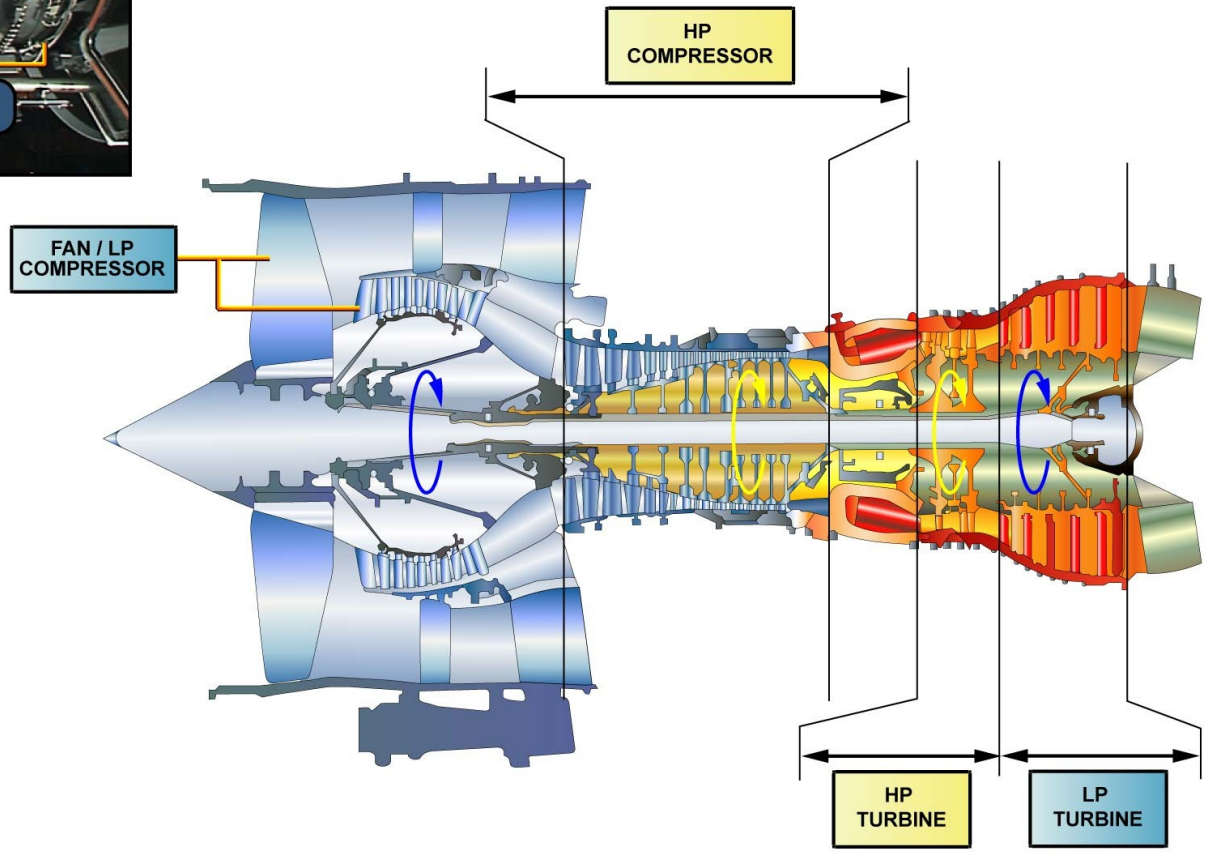

TURBINE SECTION OPERATION

ENGINE SYSTEM D/O (3)

ACCESSORY GEARBOX

The accessory gearbox has an angle gearbox assembly, a main gear assembly and external components.
The angle gearbox transmits power from the engine to the main gearbox and from the starter on the main gearbox to the engine.
The oil pressure pump receives the movement through the fuel pump drive gearshaft and supplies oil under pressure to the engine bearings and accessory gearbox.
The deoiler receives the movement through the Integrated Drive Generator (IDG) system gearshaft and separates air and oil by centrifugal action. The deaerated oil goes back to the oil system and the clean air is bled overboard.

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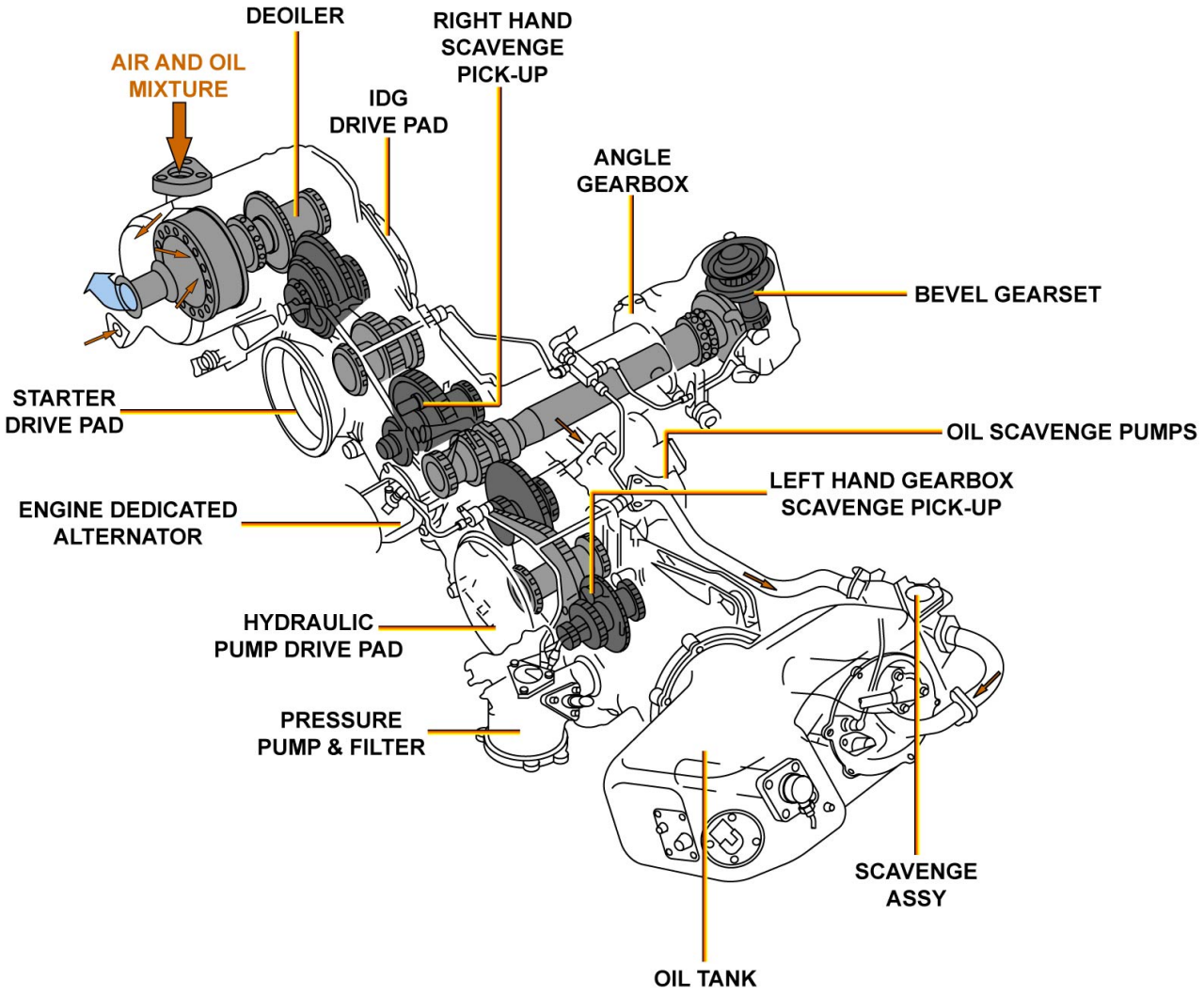

ACCESSORY GEARBOX

ENGINE SYSTEM D/O (3)

AERODYNAMIC STATIONS

Here are the main aerodynamic stations corresponding to the pressure and temperature sensors installed on the engine:
- STA 1: intake /engine inlet interfaces,
- STA 2: fan inlet,
- STA 12.5: fan exit,
- STA 2.5: LP compressor exit,
- STA 3: HP compressor exit,
- STA 4: combustion section exit,
- STA 4.5: HP turbine exit,
- STA 4.9: LP turbine exit.

Here is the compressor stage numbering:
- Stage 1.fan,
- Stages 1.5 to 2.5: booster (LP compressor),
- Stages 3 to 12: HP compressor.

Here is the turbine stage numbering:
- Stages 1 and 2: HP turbine,
- Stages 3 to 7: LP turbine.

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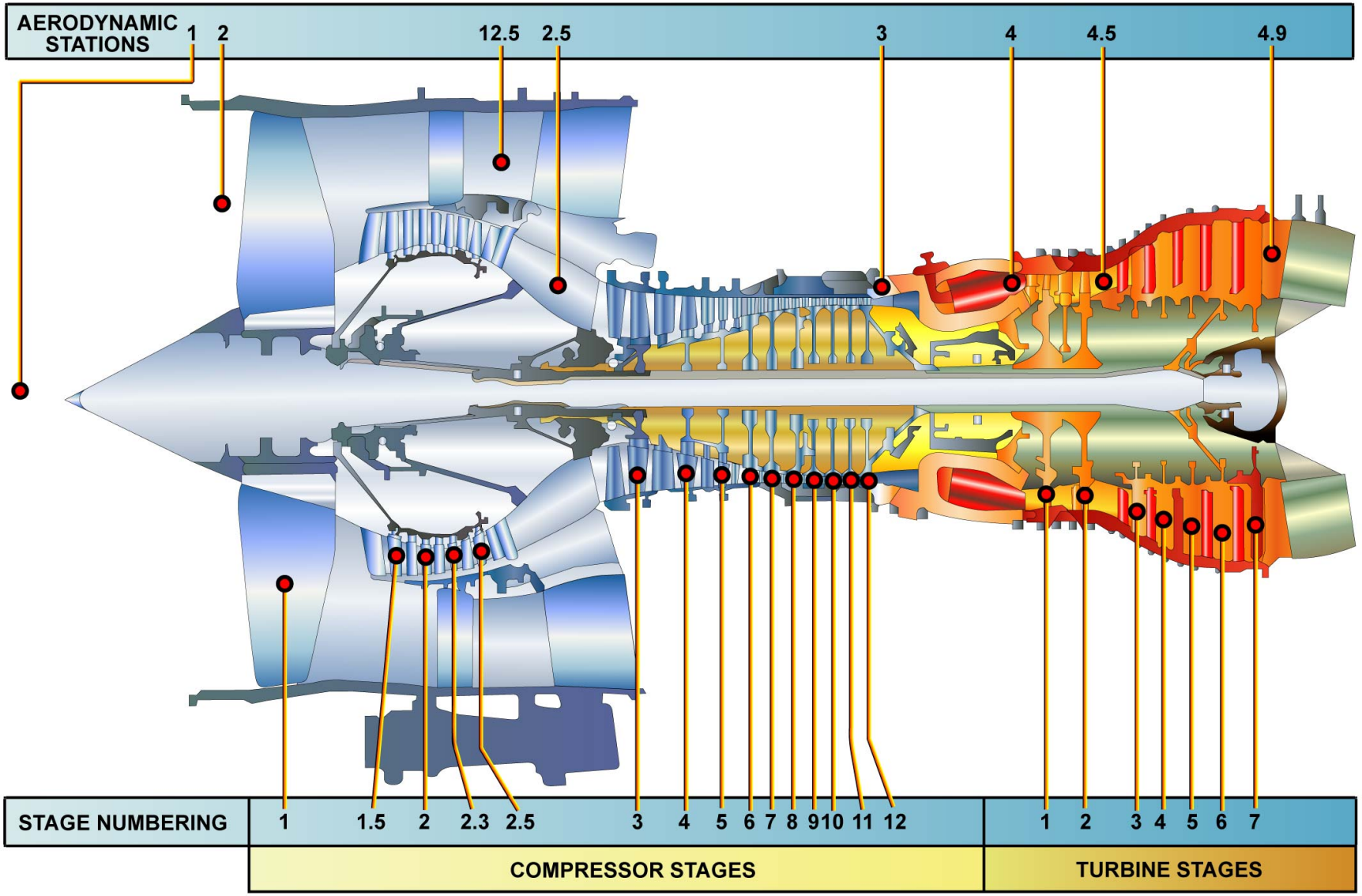
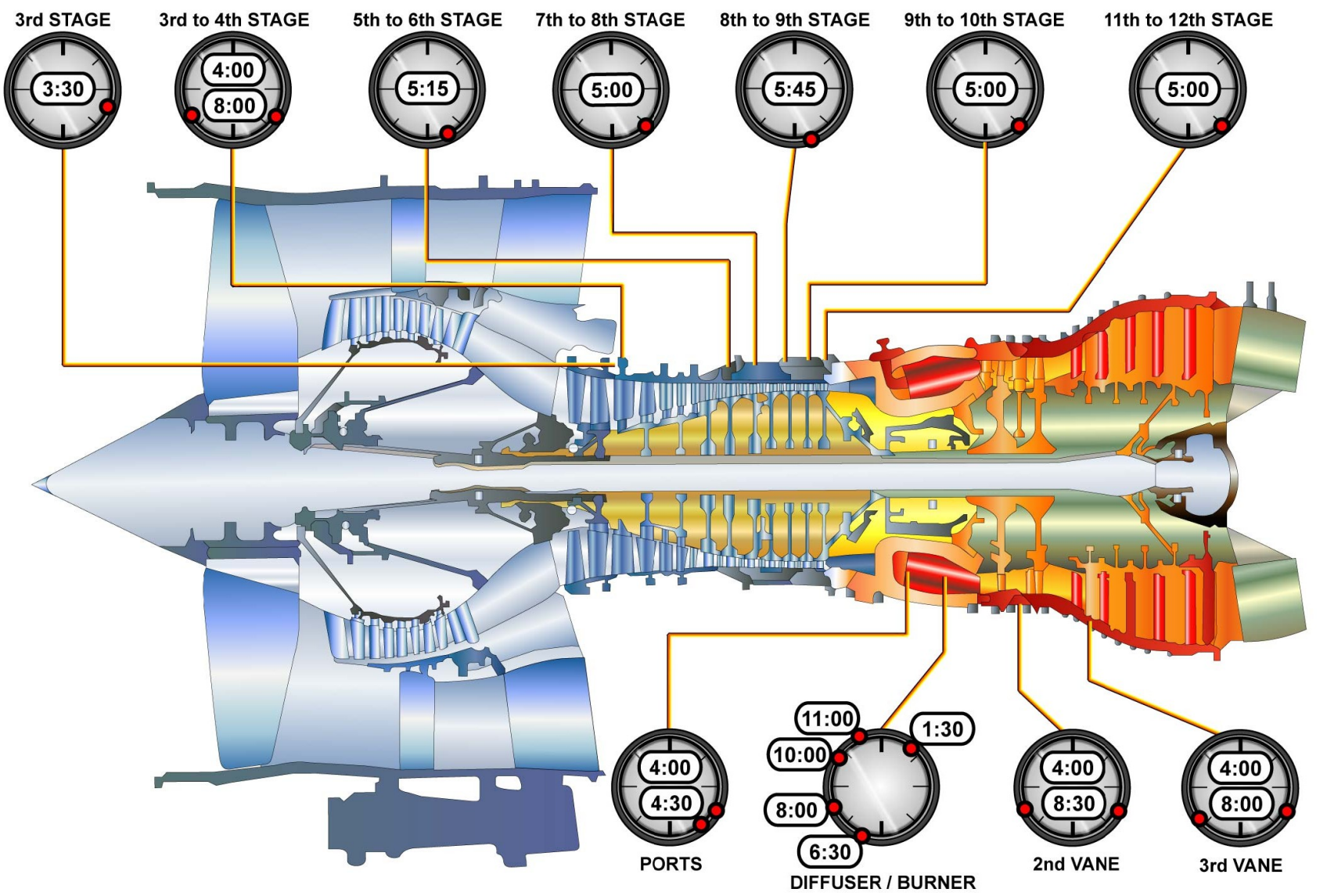


AERODYNAMIC STATIONS

ENGINE SYSTEM D/O (3)

BORESCOPE PORTS

Several ports are provided on the engine for borescope inspection.



BORESCOPE PORTS

ENGINE FUEL SYSTEM D/O (3)

FUEL FEED

The engine fuel system is designed to provide fuel flow into the combustion chamber, servo fuel for actuation of the compressor airflow control and turbine clearance control systems and cooling for engine oil and Integrated Drive Generator (IDG) oil.
The fuel coming from the aircraft tanks supplies the Low Pressure (LP) fuel pump then provides engine oil cooling, through the fuel cooled oil cooler. It then passes through the filter before entering into the High Pressure (HP) pump then into the Fuel Metering Unit (FMU). A fuel Differential Pressure (DELTA P) Switch provides indication to the cockpit if the filter is clogged. A fuel temperature sensor is installed at the fuel filter outlet for the fuel diverter and return valve operation.

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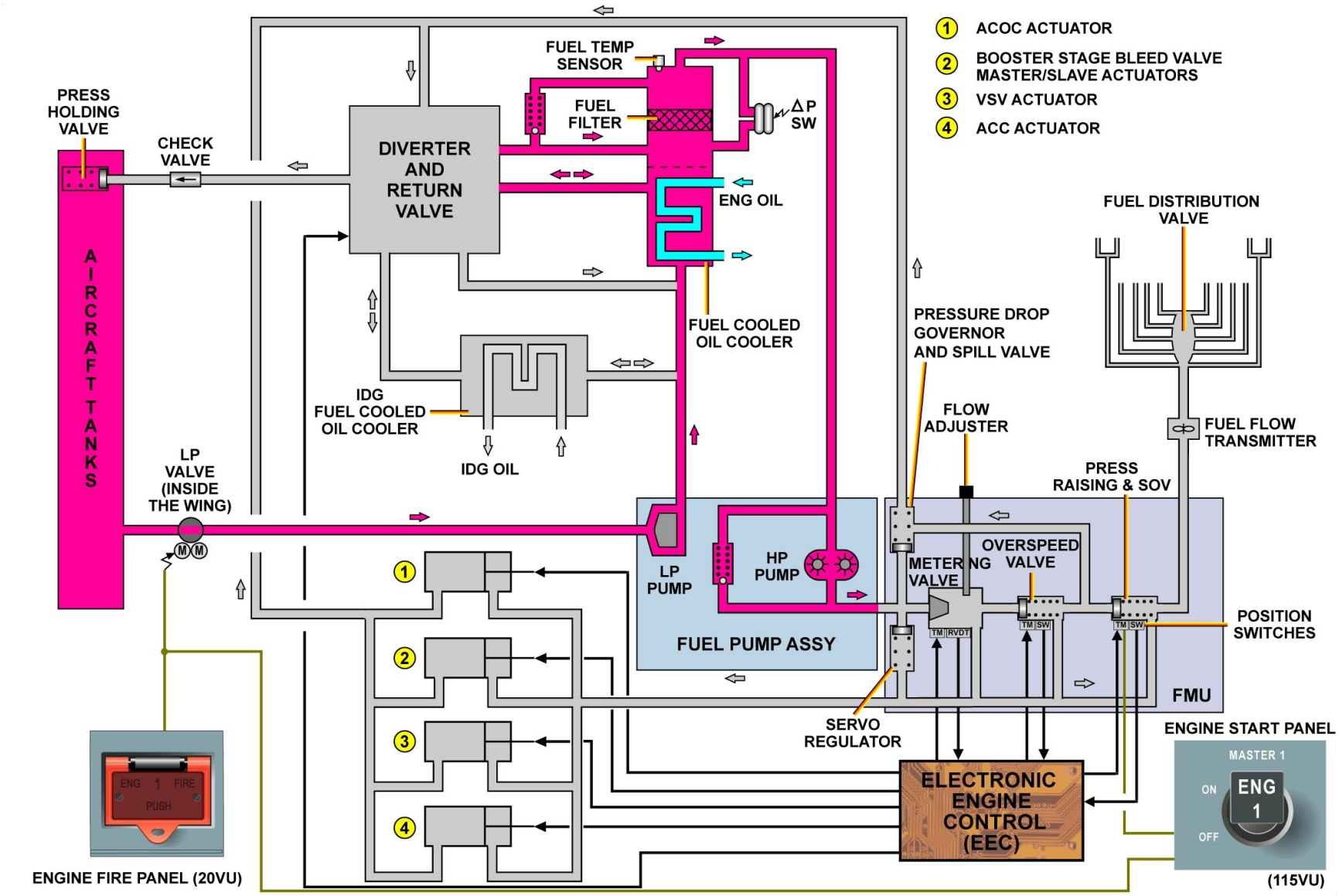

1 ACOC ACTUATOR
2 BOOSTER STAGE BLEED VALVE MASTER/SLAVE ACTUATORS
3 VSV ACTUATOR
4 ACC ACTUATOR
FUEL TEMP SENSOR
FUEL FILTER
ΔP SW
PRESS HOLDING VALVE
CHECK VALVE
DIVERTER AND RETURN VALVE
ENG OIL
FUEL DISTRIBUTION VALVE
AIRCRAFT TANKS
FUEL COOLED OIL COOLER
PRESSURE DROP GOVERNOR AND SPILL VALVE
IDG FUEL COOLED OIL COOLER
IDG OIL
FLOW ADJUSTER
FUEL FLOW TRANSMITTER
LP VALVE (INSIDE THE WING)
PRESS RAISING & SOV
OVERSPEED VALVE
METERING VALVE
LP PUMP
HP PUMP
FUEL PUMP ASSY
POSITION SWITCHES
FMU
SERVO REGULATOR
ENGINE START PANEL
ELECTRONIC ENGINE CONTROL (EEC)
MASTER 1
ON
ENG 1
OFF
ENG 1 FIRE PUSH
ENGINE FIRE PANEL (20VU)
(115VU)

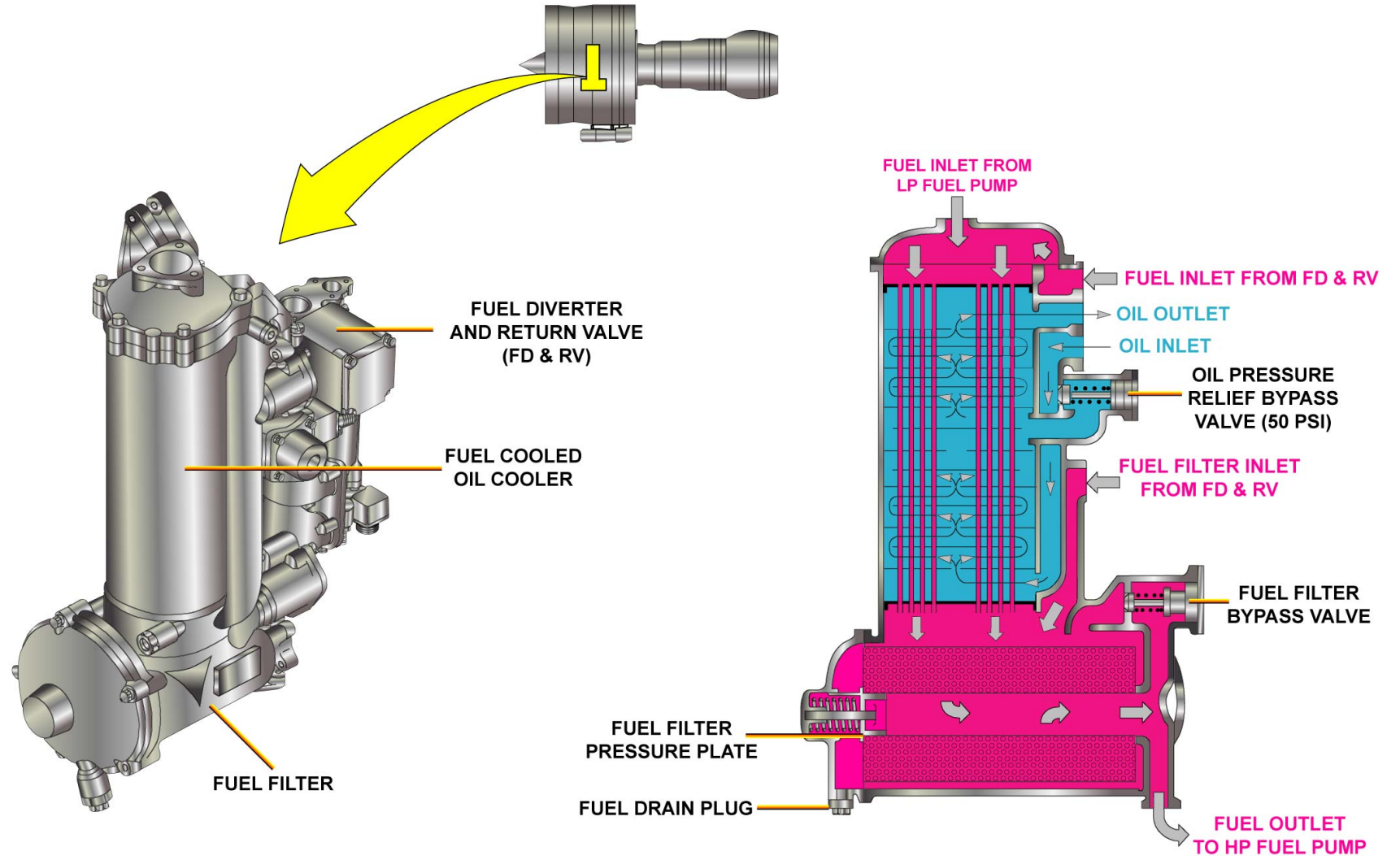
FUEL FEED

ENGINE FUEL SYSTEM D/O (3)

FUEL FEED (continued)

FUEL COOLED OIL COOLER

The Fuel Cooled Oil Cooler (FCOC) cools the engine oil by using fuel. It is installed on the left fan case.
The FCOC has a housing, containing a removable core, a header and fuel filter cap.
The core is composed of more than 700 tubes where the fuel goes through. 13 baffle plates show the way of the oil flow towards the tubes.
The FCOC has two bypass valves. One is an oil pressure relief valve for the core. This valve diverts the excessive oil pressure during cold engine start.
The other one is the fuel filter bypass valve. The fuel filter bypass valve makes sure that the fuel still flow in the event of fuel filter clogging.



FUEL FEED - FUEL COOLED OIL COOLER

ENGINE FUEL SYSTEM D/O (3)

ENGINE PRESSURE RAISING AND SHUT-OFF VALVE CONTROL

GENERAL

The pressure raising and Shut-Off Valve (SOV) can be controlled from the cockpit through the MASTER lever or by the Electronic Engine Control (EEC) during engine start.

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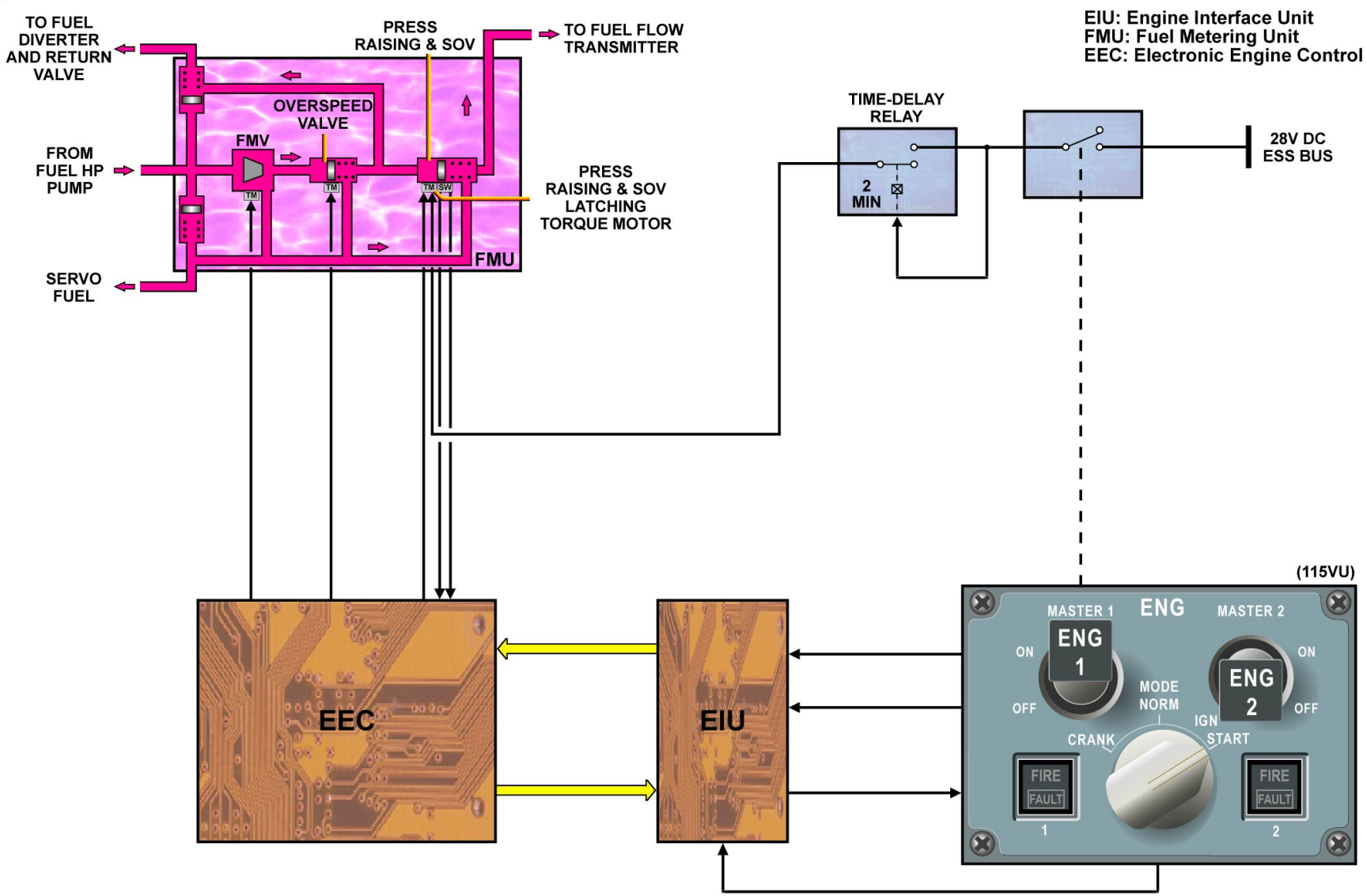

ENGINE PRESSURE RAISING AND SHUT-OFF VALVE CONTROL - GENERAL

ENGINE FUEL SYSTEM D/O (3)

ENGINE PRESSURE RAISING AND SHUT-OFF VALVE CONTROL (continued)

ENGINE MASTER LEVER OPENING COMMAND

During the start sequence, the EEC controls the opening of the Fuel Metering Valve (FMV), which causes the pressure raising and SOV to open, provided its latching torque motor is de-energized. When the MASTER lever is set to ON, the pressure raising and SOV will only open if fuel pressure from the FMV is available.

NOTE: During engine start in automatic mode, the EEC can close the pressure raising and SOV to abort the start sequence up to 50% High Pressure Rotor Speed (N2).

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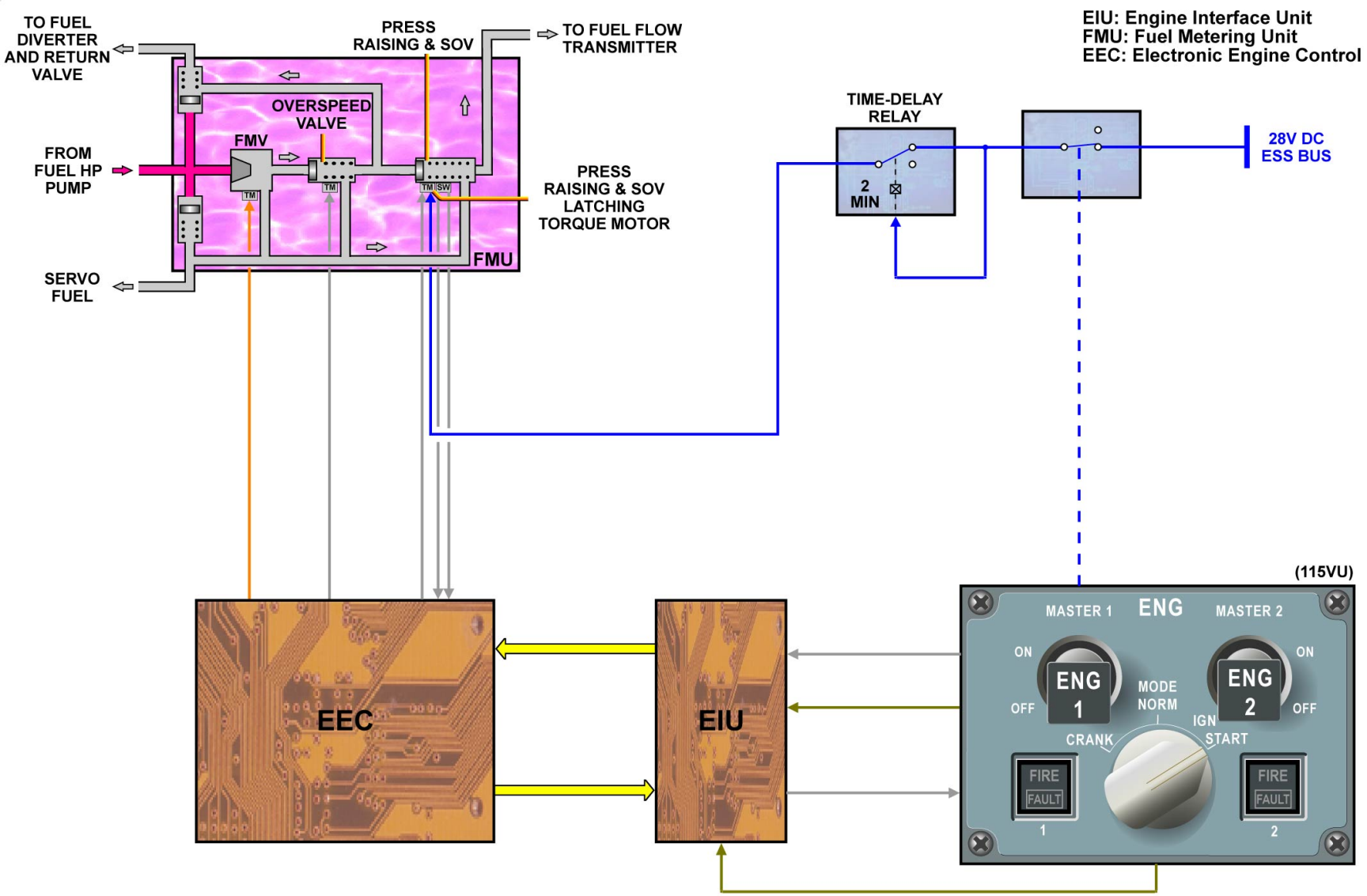
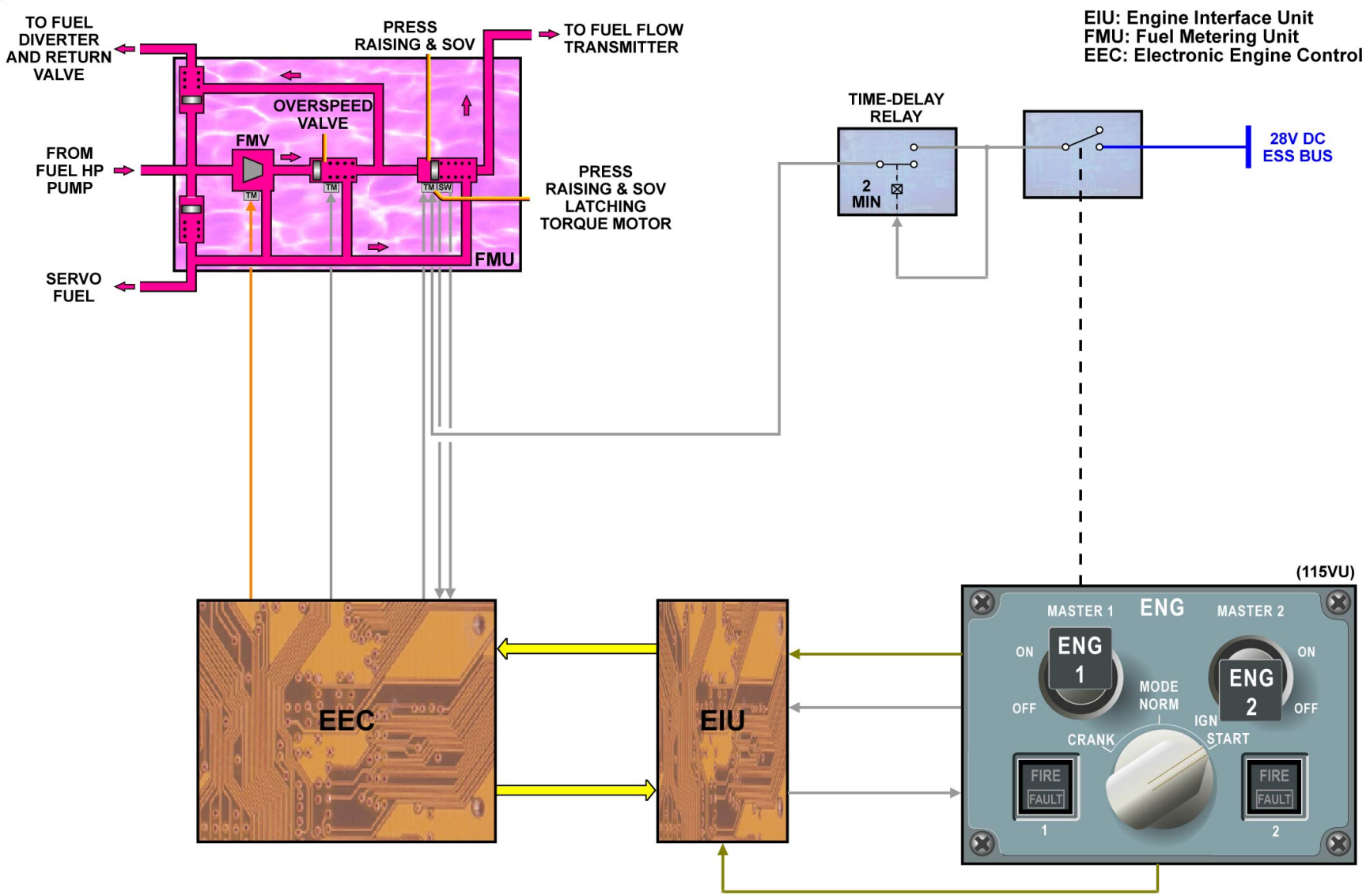


ENGINE PRESSURE RAISING AND SHUT-OFF VALVE CONTROL - ENGINE MASTER LEVER OPENING COMMAND



ENGINE PRESSURE RAISING AND SHUT-OFF VALVE CONTROL - ENGINE MASTER LEVER OPENING COMMAND

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ENGINE FUEL SYSTEM D/O (3)

ENGINE PRESSURE RAISING AND SHUT-OFF VALVE CONTROL (continued)

ENGINE MASTER LEVER CLOSURE COMMAND

The closure of the pressure raising and SOV is controlled directly from the MASTER lever. When it is set at the OFF position, it energizes the latching torque motor which closes the valve.
A time-delay relay automatically de-energizes the pressure raising and SOV latching torque motor 2 minutes after engine shutdown. This device avoids damage due to high temperature induced by a long time power supply on ground.

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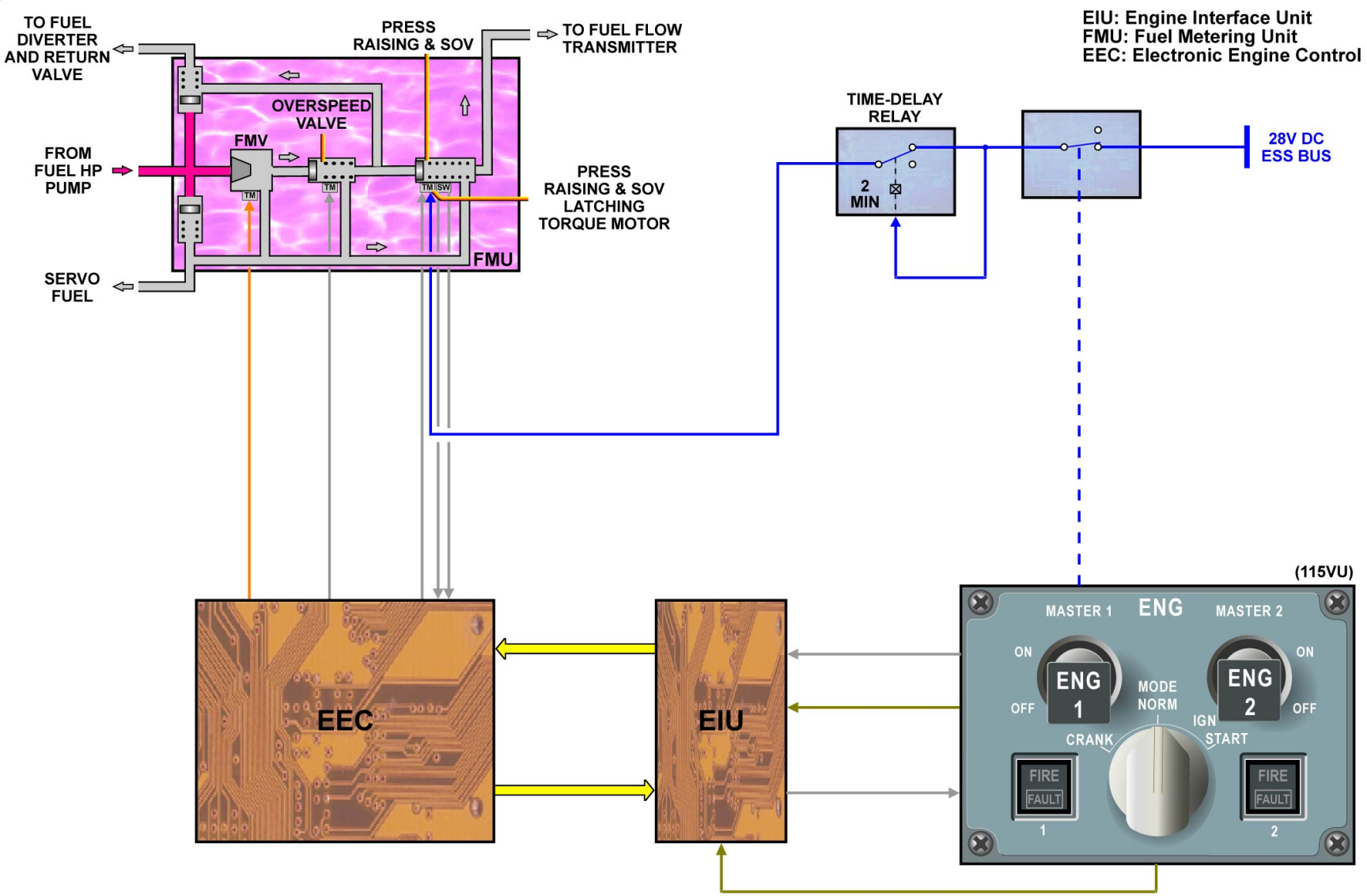
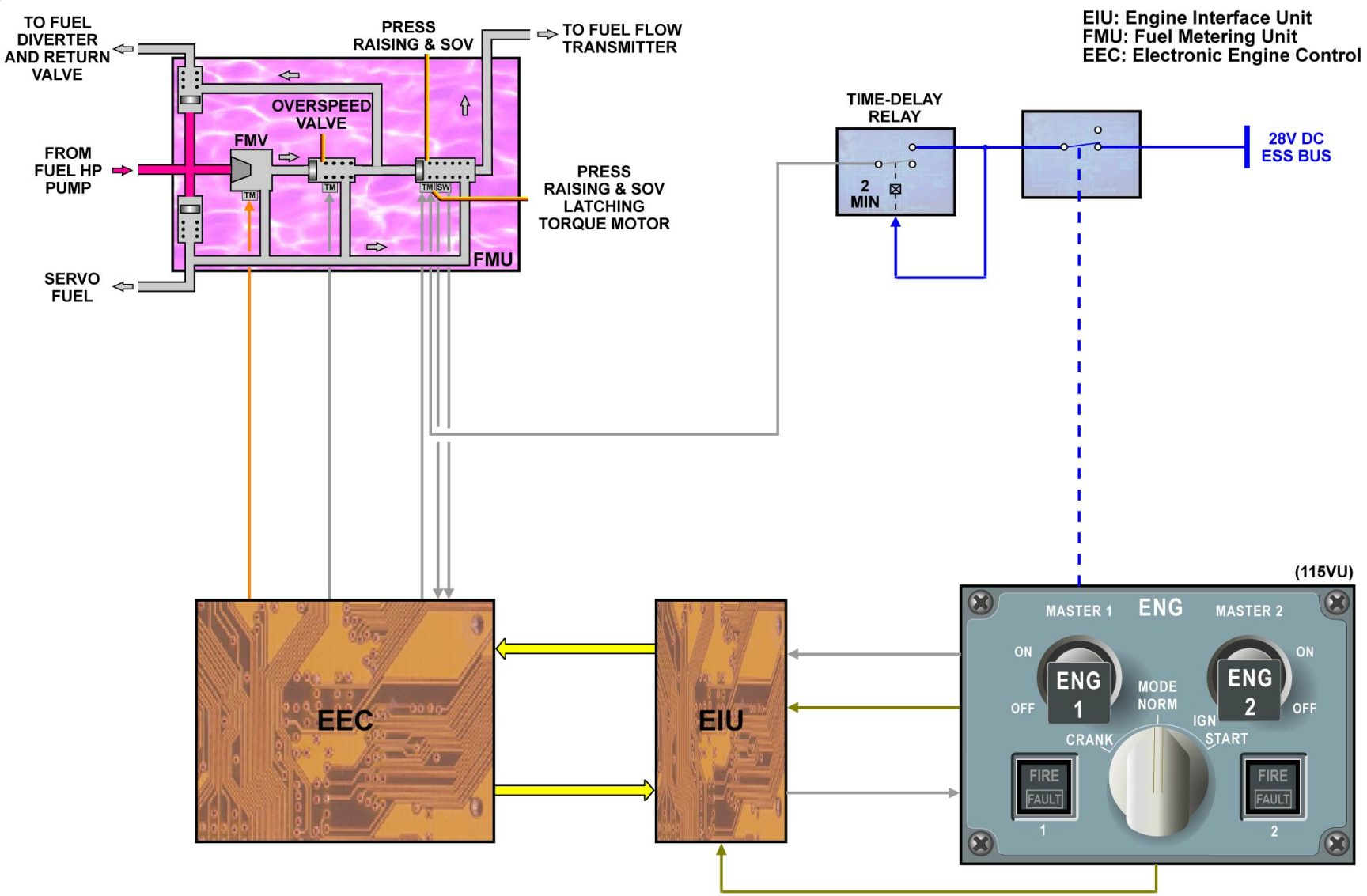


ENGINE PRESSURE RAISING AND SHUT-OFF VALVE CONTROL - ENGINE MASTER LEVER CLOSURE COMMAND



ENGINE PRESSURE RAISING AND SHUT-OFF VALVE CONTROL - ENGINE MASTER LEVER CLOSURE COMMAND

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ENGINE FUEL SYSTEM D/O (3)

ENGINE PRESSURE RAISING AND SHUT-OFF VALVE CONTROL (continued)

MONITORING

The pressure raising and SOV is monitored by two microswitches, which send signals to the EEC and then to the Engine Interface Unit (EIU). In case of disagreement between control and position, an ECAM warning is triggered and the FAULT light comes on.

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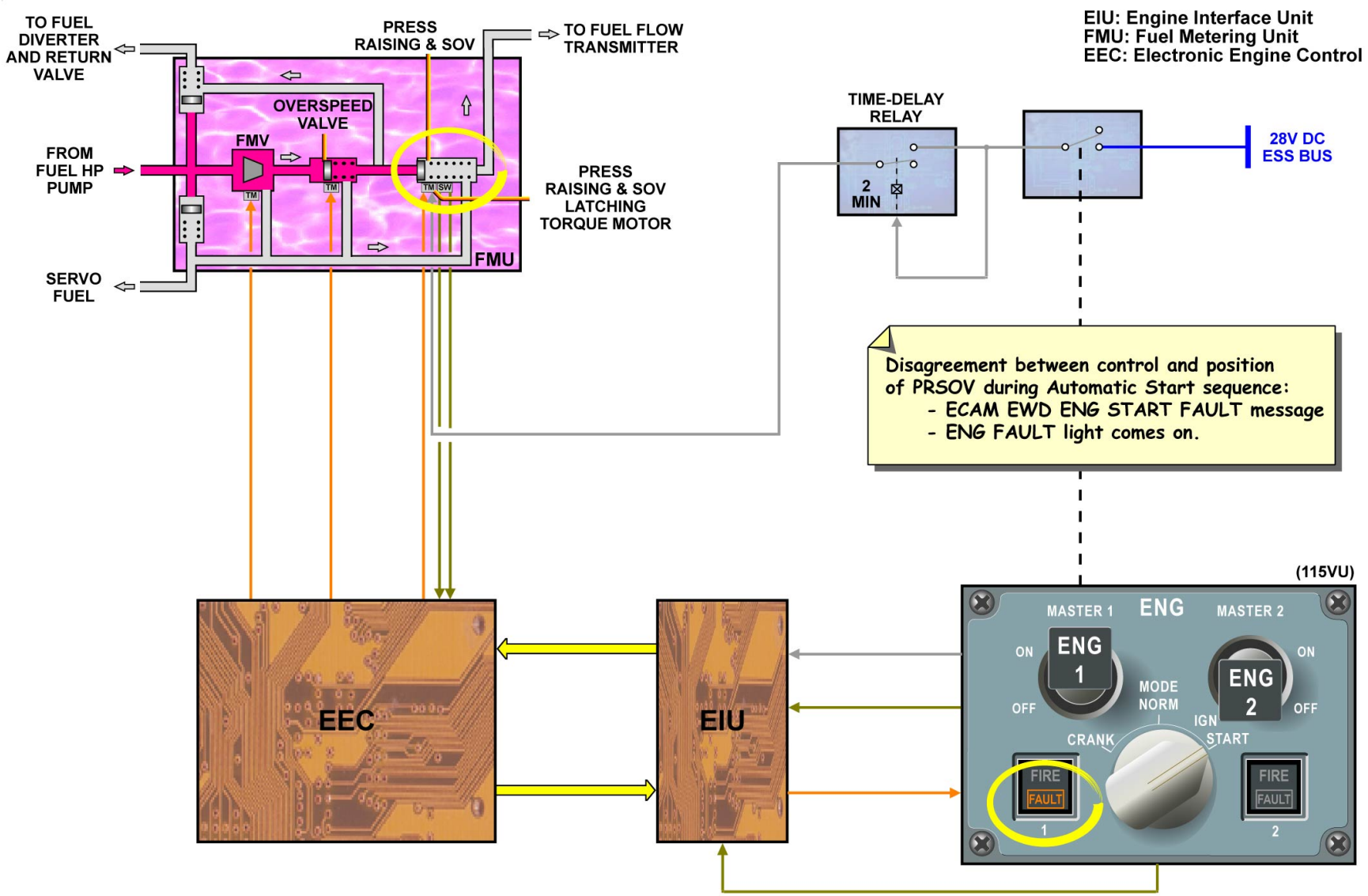

ENGINE PRESSURE RAISING AND SHUT-OFF VALVE CONTROL - MONITORING

ENGINE FUEL SYSTEM D/O (3)

METERED FUEL

The fuel from the fuel pump assembly goes through a fuel metering valve, an overspeed valve and a pressure raising and Shut-Off Valve (SOV) included in the FMU. The fuel flow is then routed to a fuel distribution valve, which supplies 20 nozzles through 10 manifolds. The Electronic Engine Control (EEC) controls the valves included in the FMU through Torque Motors (TMs) to carry out fuel metering, overspeed protection, pressure raising and shut-off functions. A flow adjuster installed below the metering valve is used for the fuel flow adjustment between "high flow" and "normal flow" by a maintenance action.

NOTE: Note: The LP SOV, pressure raising and SOV close when the ENGine MASTER lever is set to OFF. The pressure raising and SOV could be automatically closed by the EEC, during auto start only, to abort in case of an incident.

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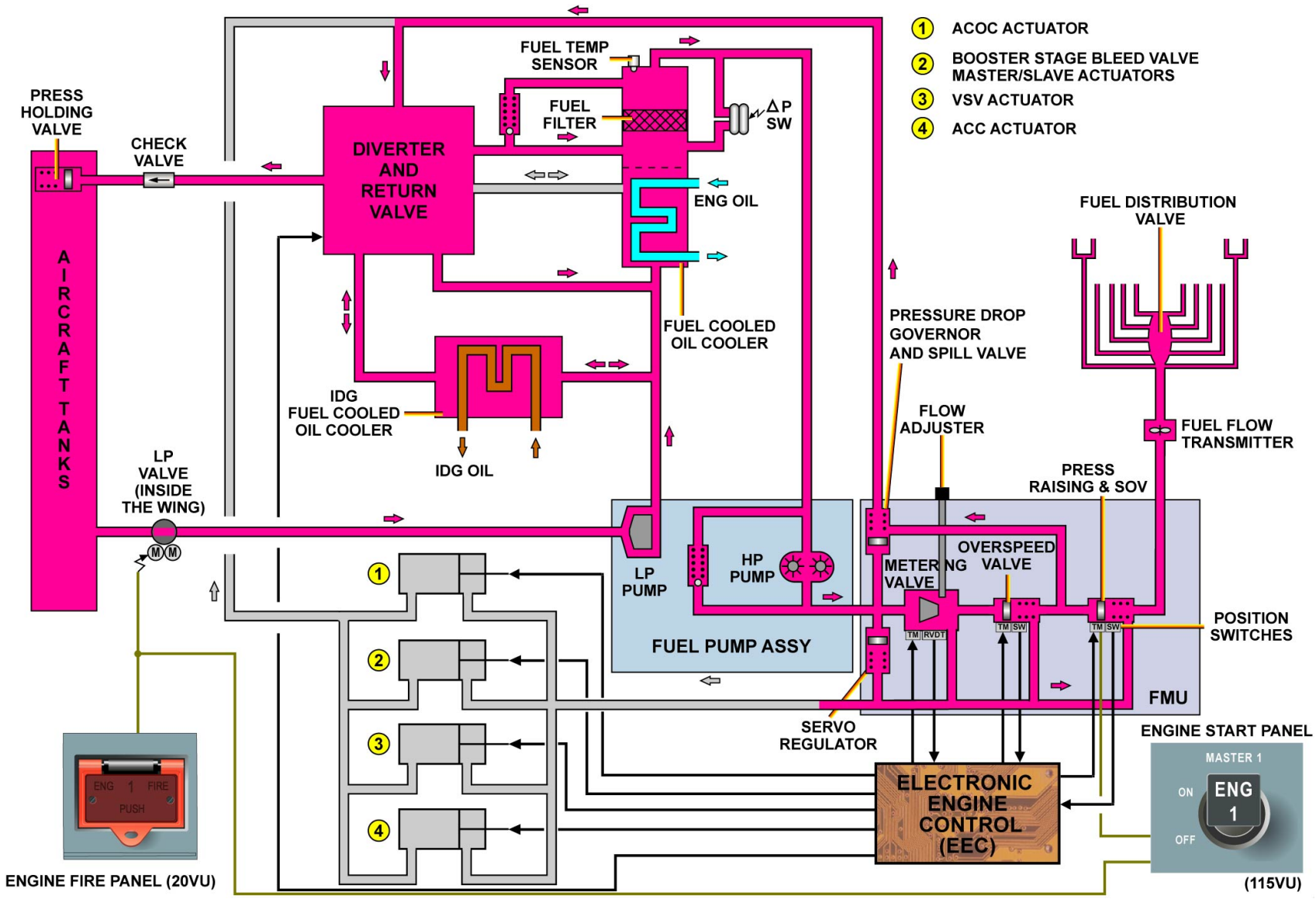

METERED FUEL

ENGINE FUEL SYSTEM D/O (3)

METERED FUEL (continued)

FUEL DISTRIBUTION VALVE

The Fuel Distribution Valve (FDV) is installed at the 4:00 o'clock location, at the front flange of the diffuser case.
The FDV receives metered fuel through a fuel line from the FMU.
The fuel goes through a 200-micron strainer and then into ten internal discharge ports. If the strainer gets blocked, a bypass valve will open.
The ten discharge ports are connected to the ten fuel manifolds, each of which in turn supplies two nozzles (20 nozzles at all).
At an engine shutdown, eight of the ten internal discharge ports in the valve are connected due to the fact, that there is no more fuel coming from the FMU and the drain valve in the FDV is spring-loaded in the closed position. This lets remaining fuel from the upper eight fuel manifolds to be drained into the engine through the two lowest fuel manifolds and their related nozzles.
The two fuel manifolds, which remain full, help to supply fuel for the next engine start.

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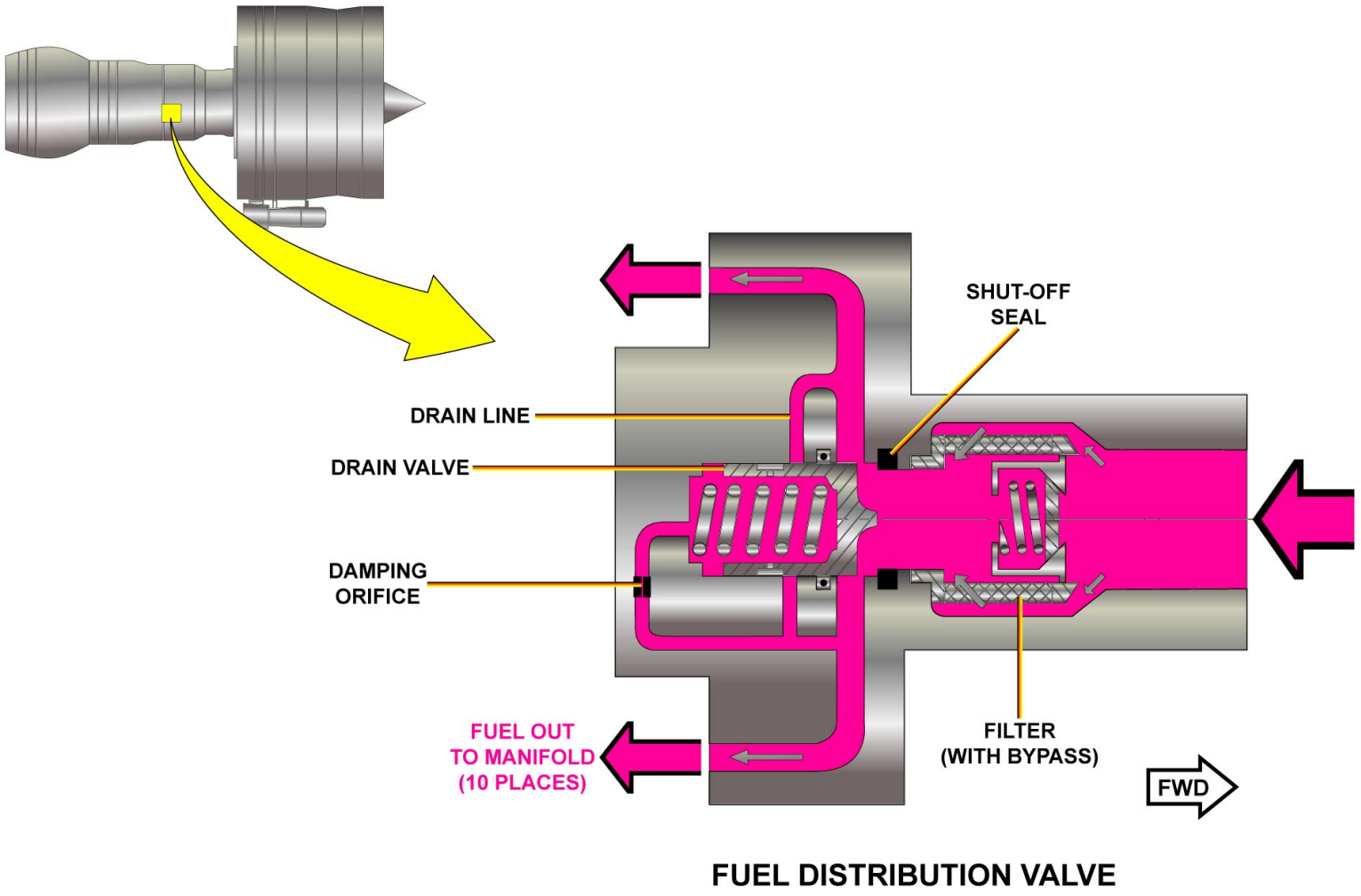

METERED FUEL - FUEL DISTRIBUTION VALVE

ENGINE FUEL SYSTEM D/O (3)

DIVERTED FUEL

Part of the fuel is used to provide adequate cooling of the engine oil and IDG oil, and to maintain engine fuel and oil temperatures within specified limits. These functions are controlled through a fuel diverter and return valve, which incorporates a module to permit fuel to be returned to the aircraft tanks under certain conditions. The EEC processes the operation modes of the fuel diverter and return valve by software logic. The logic is generated around the limiting temperatures of fuel and oil, to provide the heat management system.

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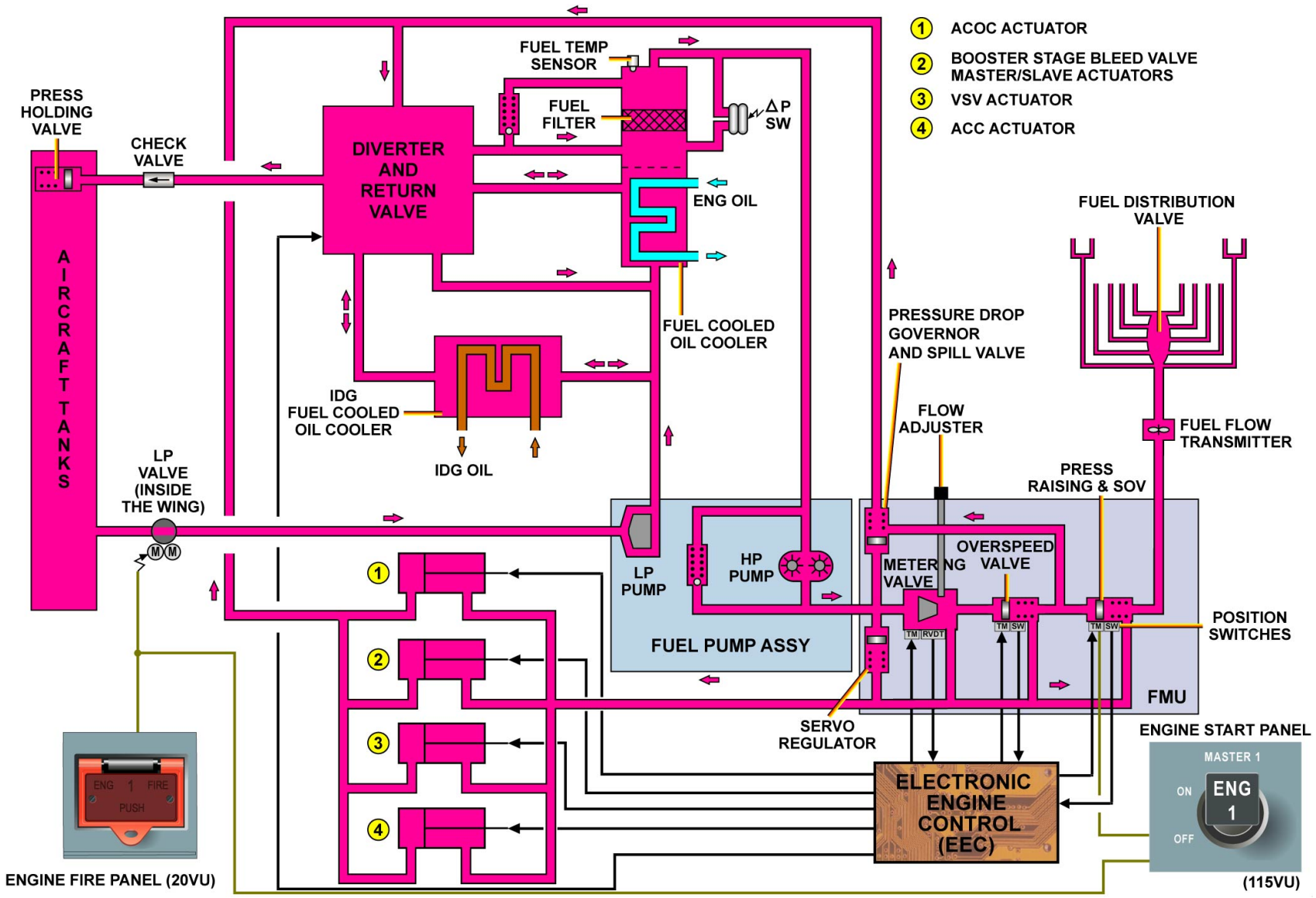

DIVERTED FUEL

ENGINE FUEL SYSTEM D/O (3)

SERVO FUEL

In the FMU, a servo regulator provides the HP fuel to:
- the FMU TM servo valves,
- the Air Cooled Oil Cooler (ACOC) actuator,
- the booster stage bleed valve actuators,
- the Variable Stator Vane (VSV) actuator,
- the Active Clearance Control (ACC) actuator.

The servo regulator of the FMU regulates a fuel pressure to the compressor airflow control systems, i.e. the booster stage bleed valve and VSV and the pressure of the turbine ACC system.

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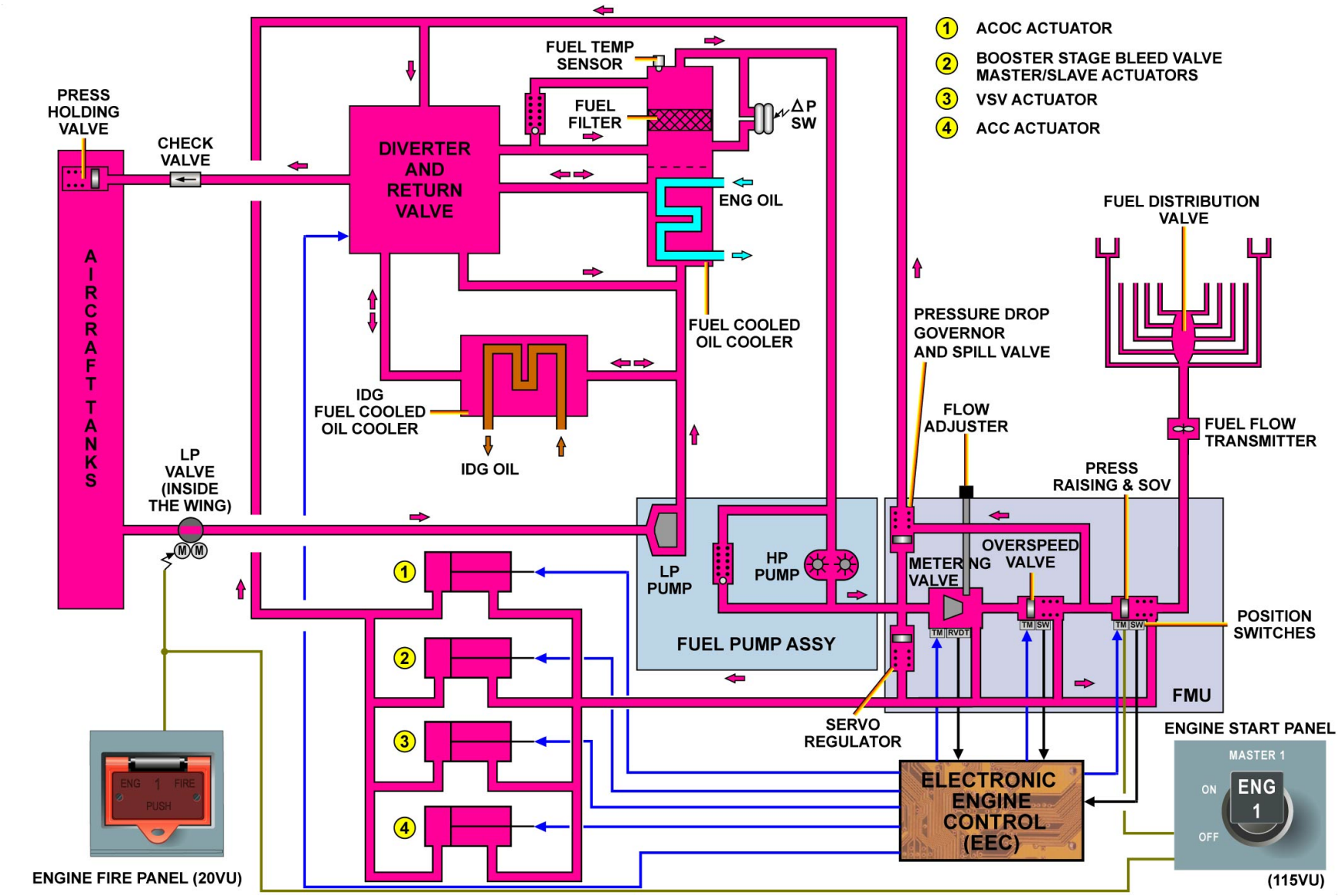
1 ACOC ACTUATOR
2 BOOSTER STAGE BLEED VALVE MASTER/SLAVE ACTUATORS
3 VSV ACTUATOR
4 ACC ACTUATOR
FUEL TEMP SENSOR
FUEL FILTER
ΔP SW
PRESS HOLDING VALVE
CHECK VALVE
DIVERTER AND RETURN VALVE
ENG OIL
FUEL DISTRIBUTION VALVE
AIRCRAFT TANKS
FUEL COOLED OIL COOLER
PRESSURE DROP GOVERNOR AND SPILL VALVE
IDG FUEL COOLED OIL COOLER
IDG OIL
FLOW ADJUSTER
FUEL FLOW TRANSMITTER
LP VALVE (INSIDE THE WING)
PRESS RAISING & SOV
LP PUMP
HP PUMP
METERING VALVE
OVERSPEED VALVE
FUEL PUMP ASSY
POSITION SWITCHES
FMU
SERVO REGULATOR
ENGINE START PANEL
ELECTRONIC ENGINE CONTROL (EEC)
MASTER 1
ON
ENG 1
OFF
ENG 1 FIRE PUSH
ENGINE FIRE PANEL (20VU)
(115VU)

SERVO FUEL

ENGINE FUEL SYSTEM D/O (3)

EEC CONTROL

The EEC controls the operation of the FMU TM servo valves, the fuel diverter and return valve, the ACOC actuator, the actuators of the booster stage bleed valve, VSV and ACC systems. The EEC performs control functions and fault analysis required to regulate the fuel and to maintain the engine operation in all conditions. In the event of loss of control functions on both channels, each servo valve and actuator has a fail-safe position.

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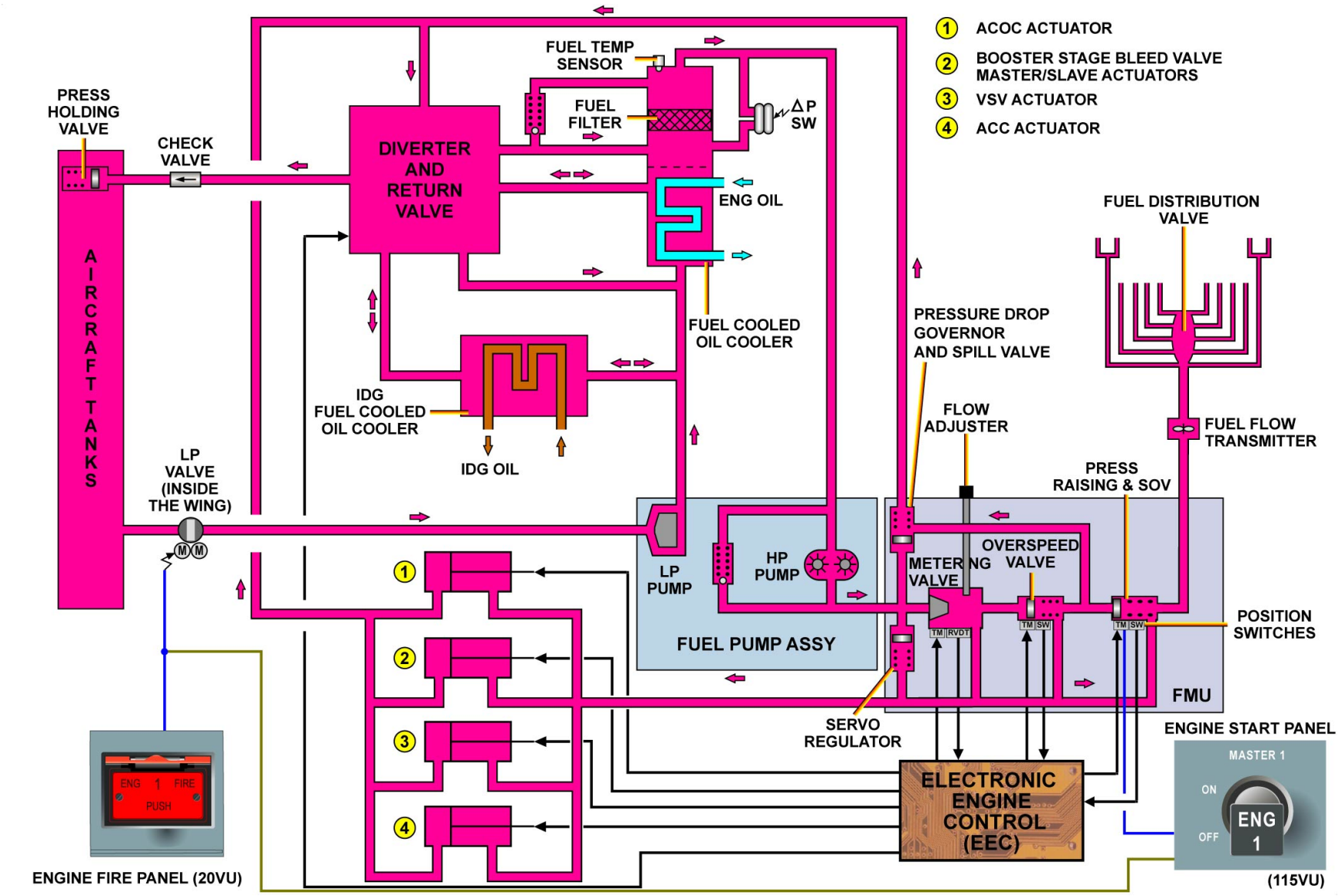
1 ACOC ACTUATOR
2 BOOSTER STAGE BLEED VALVE MASTER/SLAVE ACTUATORS
3 VSV ACTUATOR
4 ACC ACTUATOR
FUEL TEMP SENSOR
FUEL FILTER
ΔP SW
PRESS HOLDING VALVE
CHECK VALVE
DIVERTER AND RETURN VALVE
ENG OIL
FUEL COOLED OIL COOLER
FUEL DISTRIBUTION VALVE
PRESSURE DROP GOVERNOR AND SPILL VALVE
IDG FUEL COOLED OIL COOLER
IDG OIL
FLOW ADJUSTER
FUEL FLOW TRANSMITTER
AIRCRAFT TANKS
LP VALVE (INSIDE THE WING)
PRESS RAISING & SOV
OVERSPEED VALVE
METERING VALVE
LP PUMP
HP PUMP
FUEL PUMP ASSY
POSITION SWITCHES
FMU
SERVO REGULATOR
ENGINE START PANEL
MASTER 1
ON
OFF
ENG 1
ELECTRONIC ENGINE CONTROL (EEC)
ENG 1 FIRE PUSH
ENGINE FIRE PANEL (20VU)
(115VU)

EEC CONTROL

ENGINE FUEL SYSTEM D/O (3)

ENGINE SHUT DOWN

Normal Engine Shut Down:
When the Master switch is set from On to OFF, an electrical signal is sent directly to the Pressure Raising and Shut Off Valve (PRSOV) Torque Motor (TM). The PRSOV closes and the fuel flow to the Fuel Distribution Valve and the combustion chamber is stopped.
A second electrical signal is sent to the two motors of the LP Valve, which is controlled to close, to isolate the aircraft fuel system from the engine. The EEC closes the Fuel Metering Valve (FMV)
In case of an engine fire, after the Master Switch is set to OFF, the Fire Pushbutton is released out to confirm the closure of the LP Valve.

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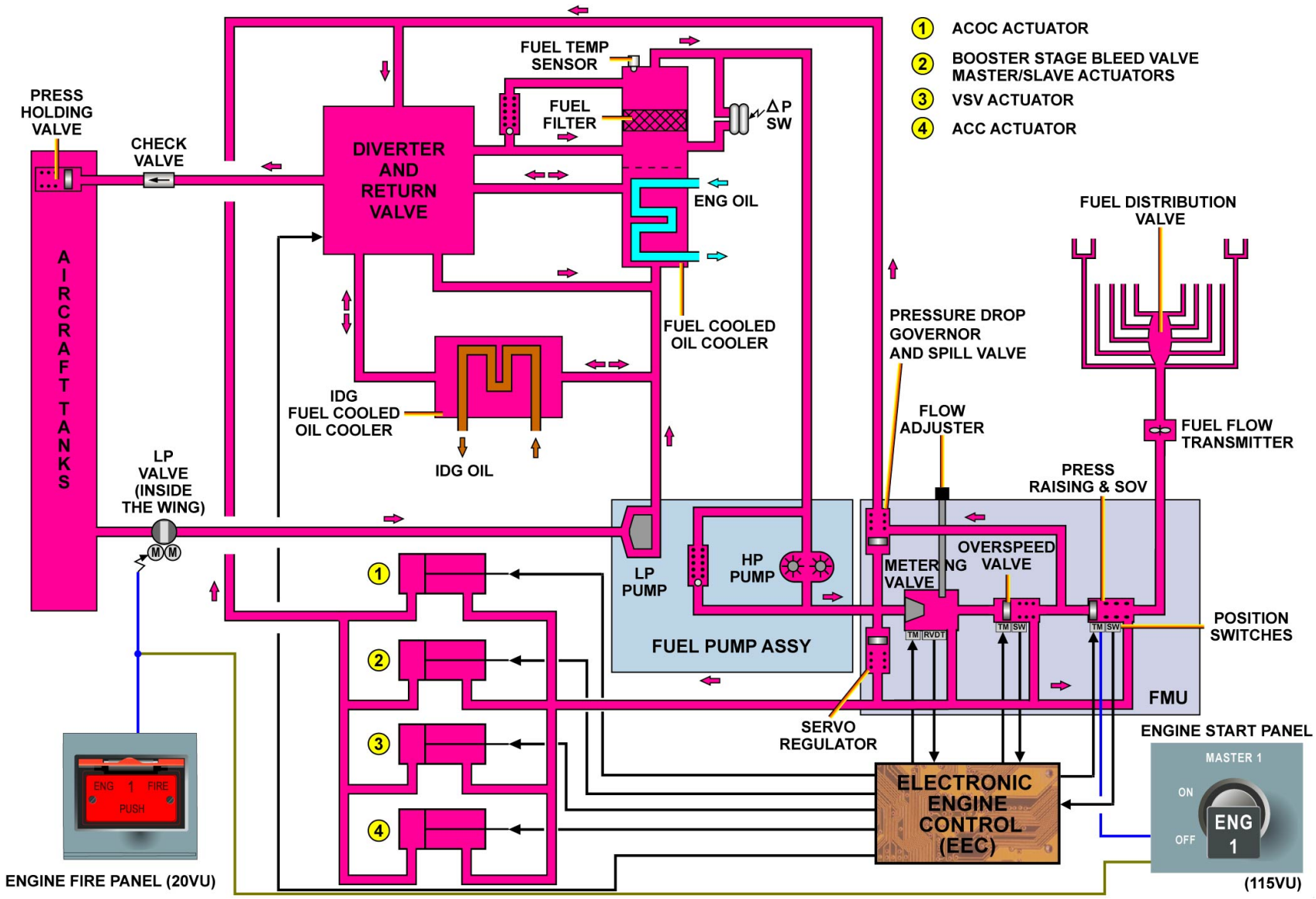


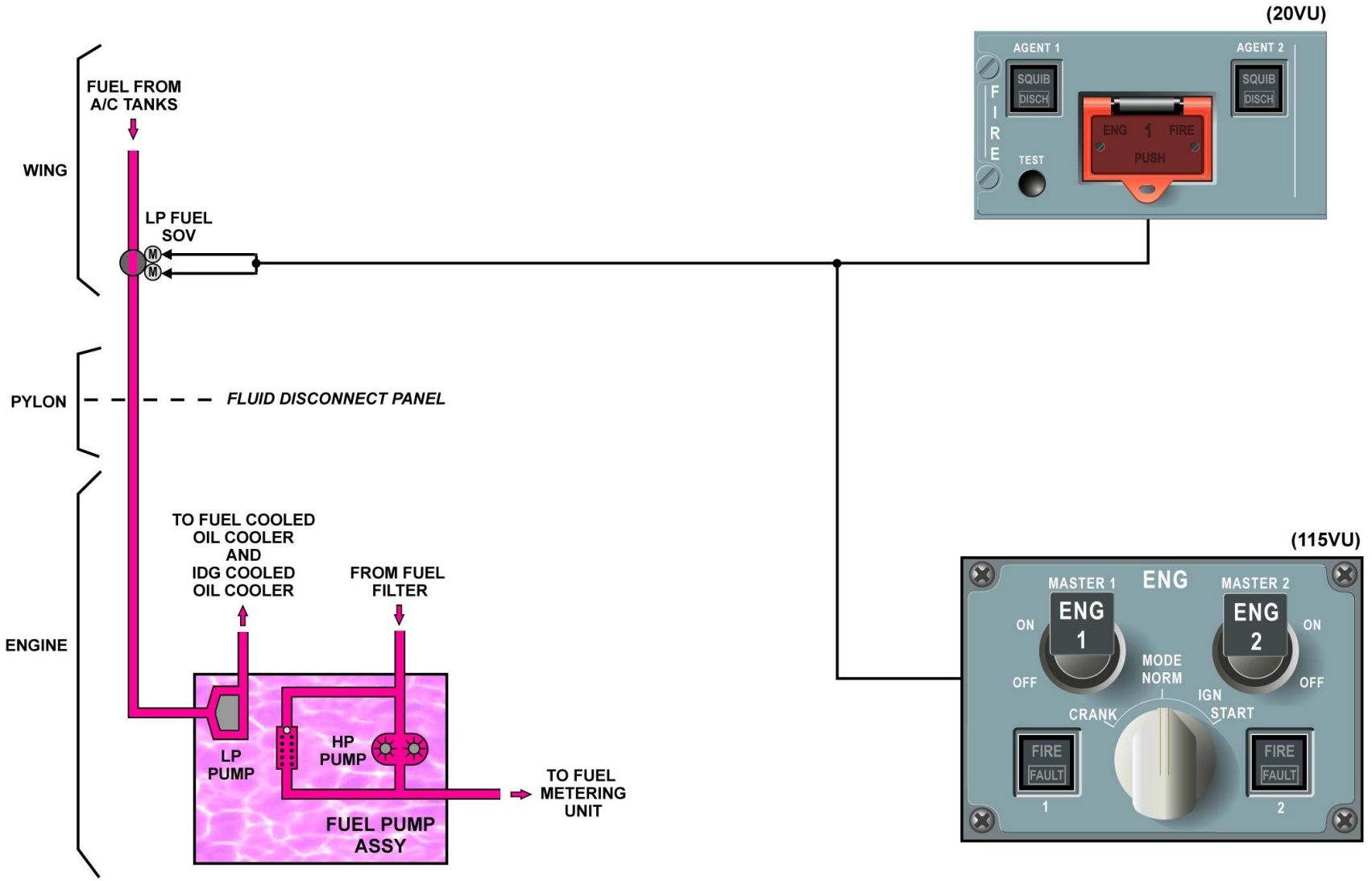
ENGINE SHUT DOWN

ENGINE FUEL SYSTEM D/O (3)

ENGINE LP FUEL SHUT-OFF VALVE CONTROL

GENERAL

The LP fuel Shut-Off Valve (SOV) operation is controlled from the engine FIRE panel or from the ENGine start panel.



ENGINE LP FUEL SHUT-OFF VALVE CONTROL - GENERAL

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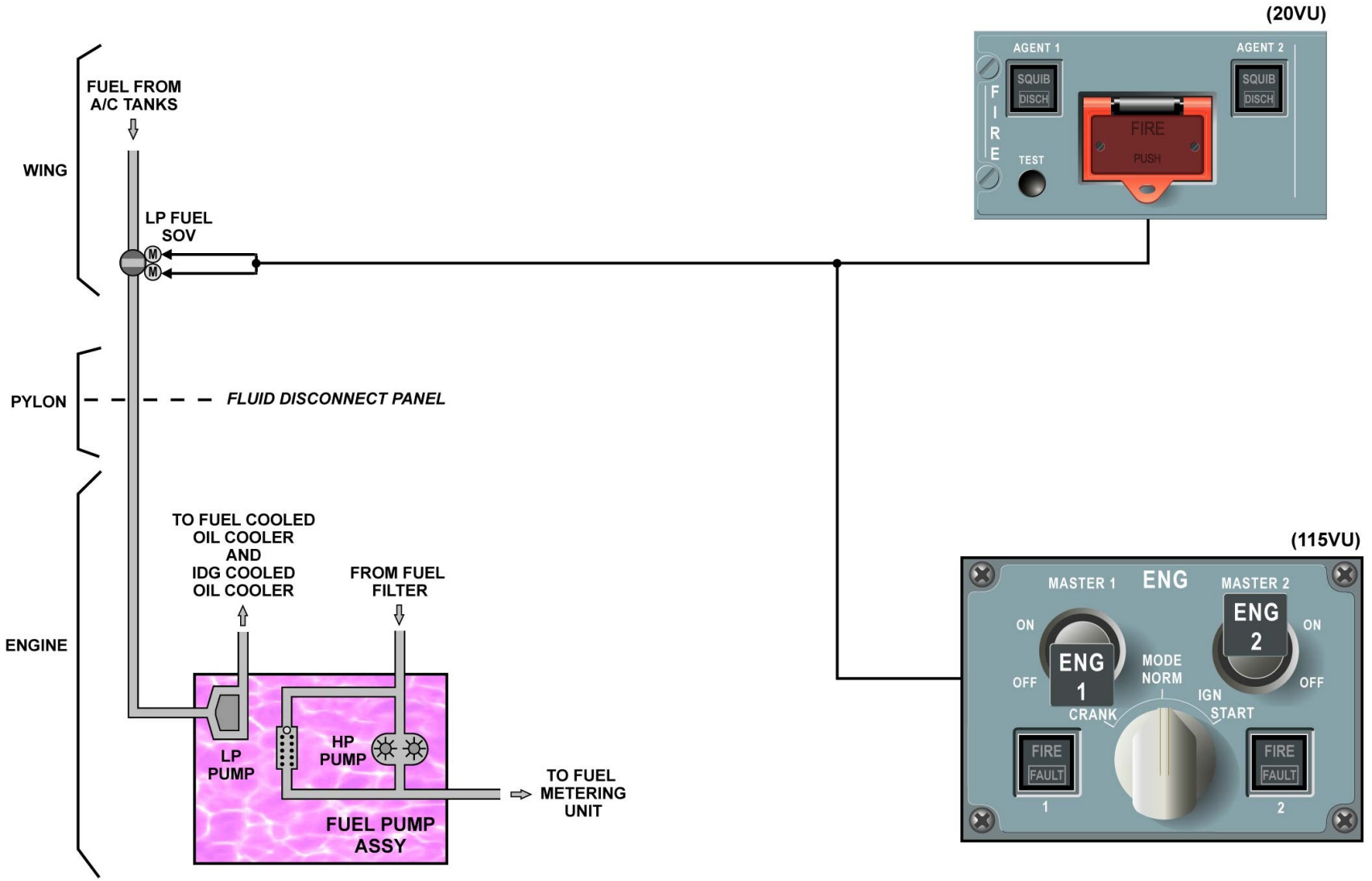
ENGINE FUEL SYSTEM D/O (3)

ENGINE LP FUEL SHUT-OFF VALVE CONTROL (continued)

ENGINE MASTER LEVER CONTROL

When the MASTER lever is set to OFF, both electrical motors drive the LP SOV to the closed position.



ENGINE LP FUEL SHUT-OFF VALVE CONTROL - ENGINE MASTER LEVER CONTROL

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ENGINE FUEL SYSTEM D/O (3)

ENGINE LP FUEL SHUT-OFF VALVE CONTROL (continued)

ENGINE FIRE P/B COMMAND

When the ENG FIRE P/B is released out, both electrical motors drive the LP SOV to the closed position.

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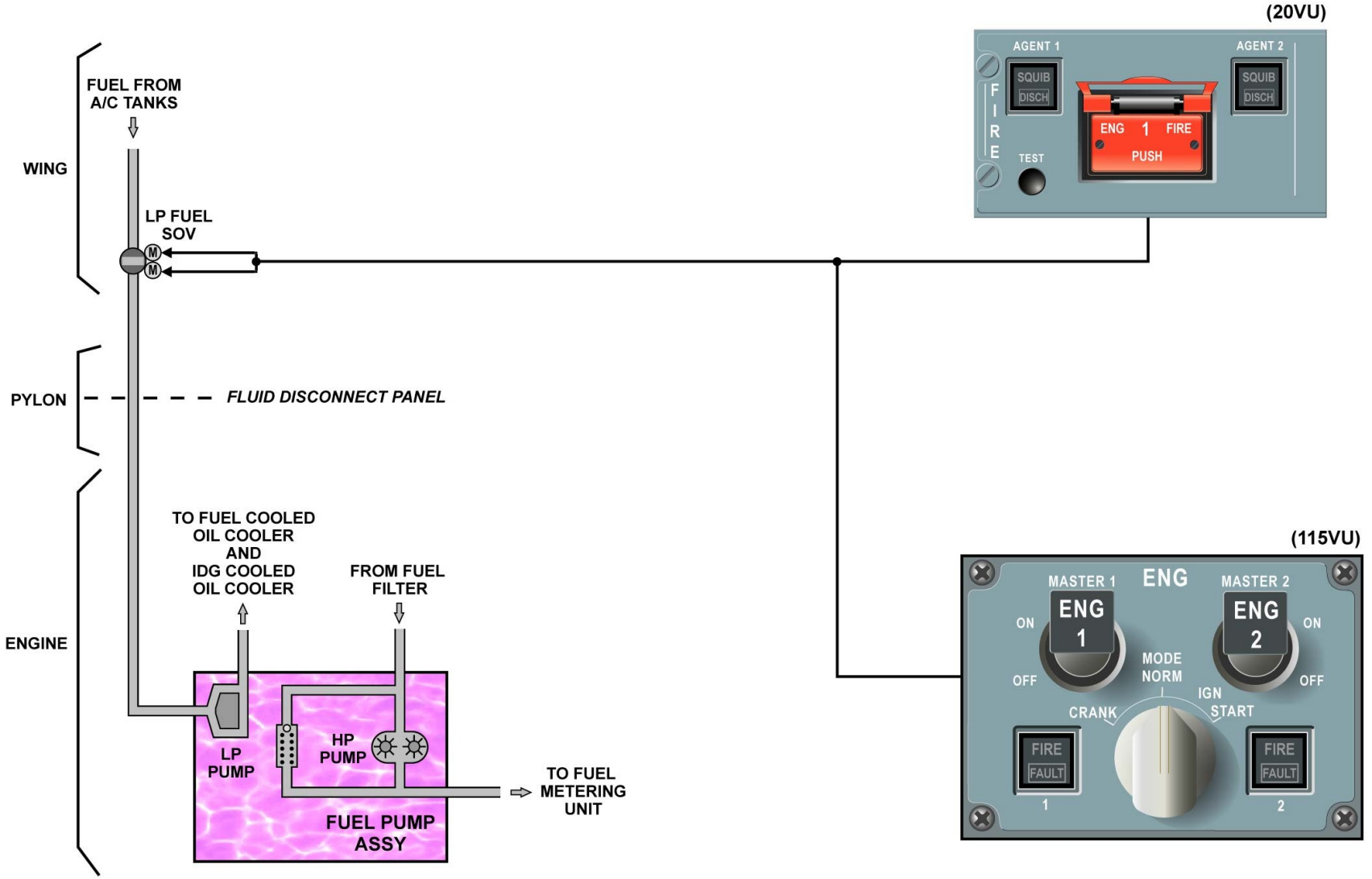

ENGINE LP FUEL SHUT-OFF VALVE CONTROL - ENGINE FIRE P/B COMMAND

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HEAT MANAGEMENT SYSTEM D/O (3)

GENERAL

Heating and cooling of the fuel, engine oil and Integrated Drive Generator (IDG) oil is performed by the fuel cooled oil cooler, the Air Cooled Oil Cooler (ACOC) and the IDG fuel cooled oil cooler under the control of the Electronic Engine Control (EEC). The EEC acts on the heat management system through the Fuel Diverter and Return to tank Valve (FDRV) and the ACOC modulating valve.

ACOC MODULATING VALVE

Oil heated by the engine passes through the ACOC and then to the fuel cooled oil cooler. The ACOC modulating valve regulates a bleed part of fan airflow crossing the ACOC to maintain both oil and fuel temperatures within acceptable minimum and maximum limits.

FUEL DIVERTER AND RETURN TO TANK VALVE (FDRV)

The fuel diverter valve and the return to tank valve are enclosed in the same housing. The FDRV maintain fuel, engine oil and IDG oil temperatures within limits by minimizing ACOC cooling air usage. The two-position diverter valve works by managing the fuel recirculation inside the engine fuel system. The return to tank valve will divert a modulated proportion of the LP fuel back to the aircraft tanks.

CONTROL

The EEC controls the heat management system through 4 modes of operation taking into account 3 parameters of temperature:
- engine fuel,
- engine oil,
- IDG oil.

The temperature of the aircraft fuel tanks and the engine power setting are parameters used for inhibition of fuel return to aircraft tanks.

NOTE: Note: The 4 modes of operation are modes 1, 3, 4 and 5:
- modes 1 and 4 are return to tank modes,
- modes 3 and 5 are no return to tank modes.

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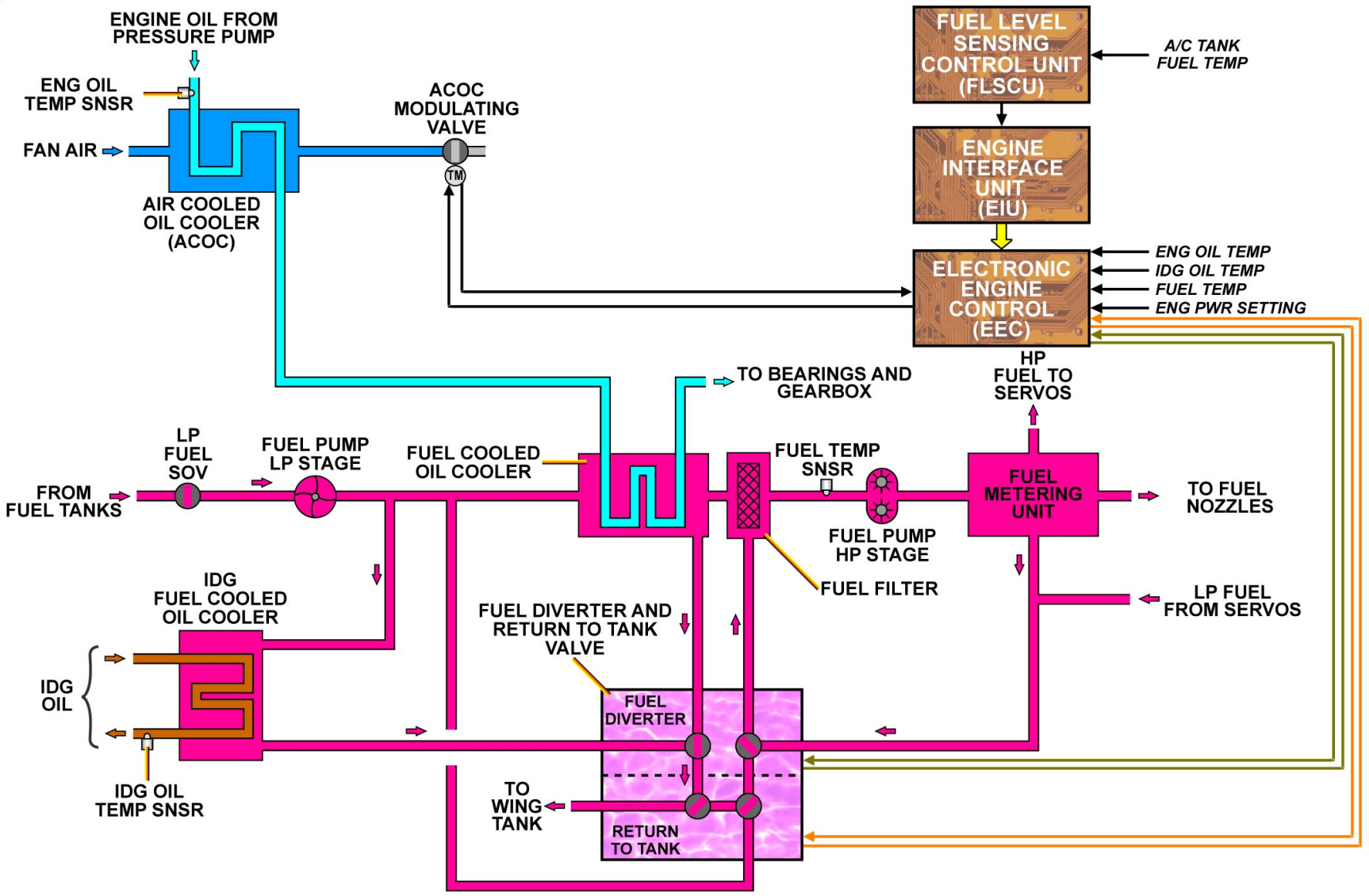


GENERAL ... CONTROL

HEAT MANAGEMENT SYSTEM D/O (3)

COMPONENTS

IDG FUEL COOLED OIL COOLER

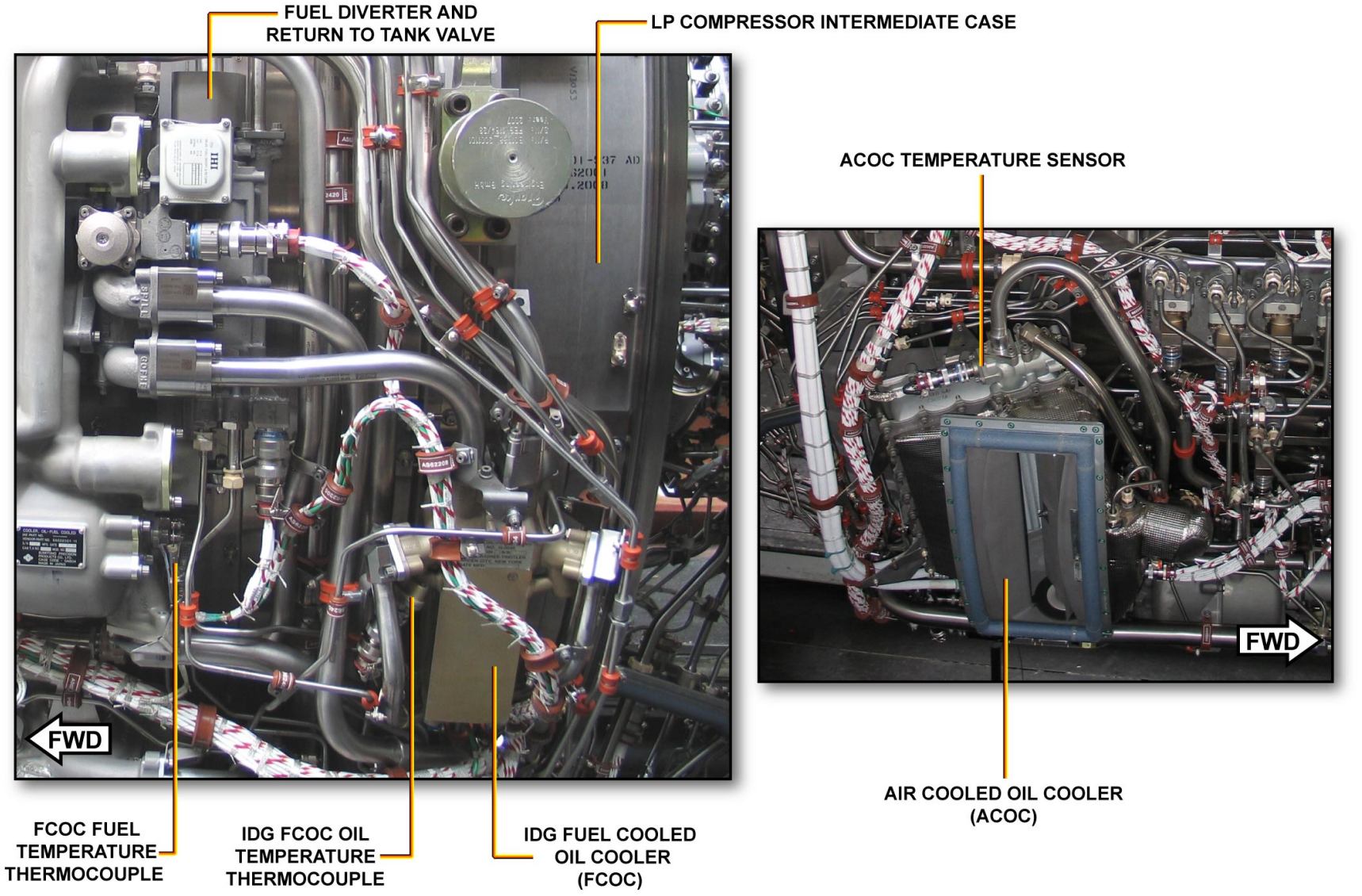
The IDG Fuel Cooled Oil Cooler (FCOC) is installed on the LH side of the LP compressor intermediate case.

FUEL DIVERTER AND RETURN TO TANK VALVE (FDRV)

The FDRV is installed on the fuel filter.

AIR COOLED OIL COOLER

The ACOC is mounted on the RH side of the engine fan case.


FUEL DIVERTER AND RETURN TO TANK VALVE
LP COMPRESSOR INTERMEDIATE CASE
ACOC TEMPERATURE SENSOR
FWD
FWD
FCOC FUEL TEMPERATURE THERMOCOUPLE
IDG FCOC OIL TEMPERATURE THERMOCOUPLE
IDG FUEL COOLED OIL COOLER (FCOC)
AIR COOLED OIL COOLER (ACOC)

COMPONENTS - IDG FUEL COOLED OIL COOLER ... AIR COOLED OIL COOLER

HEAT MANAGEMENT SYSTEM D/O (3)

OPERATION

MODE 1

Normal return to tank mode: When the engine is not at high power setting, some of the fuel is returned to the tank. The heat is absorbed and dissipated within the tank. The ACOC modulating valve is fully closed.

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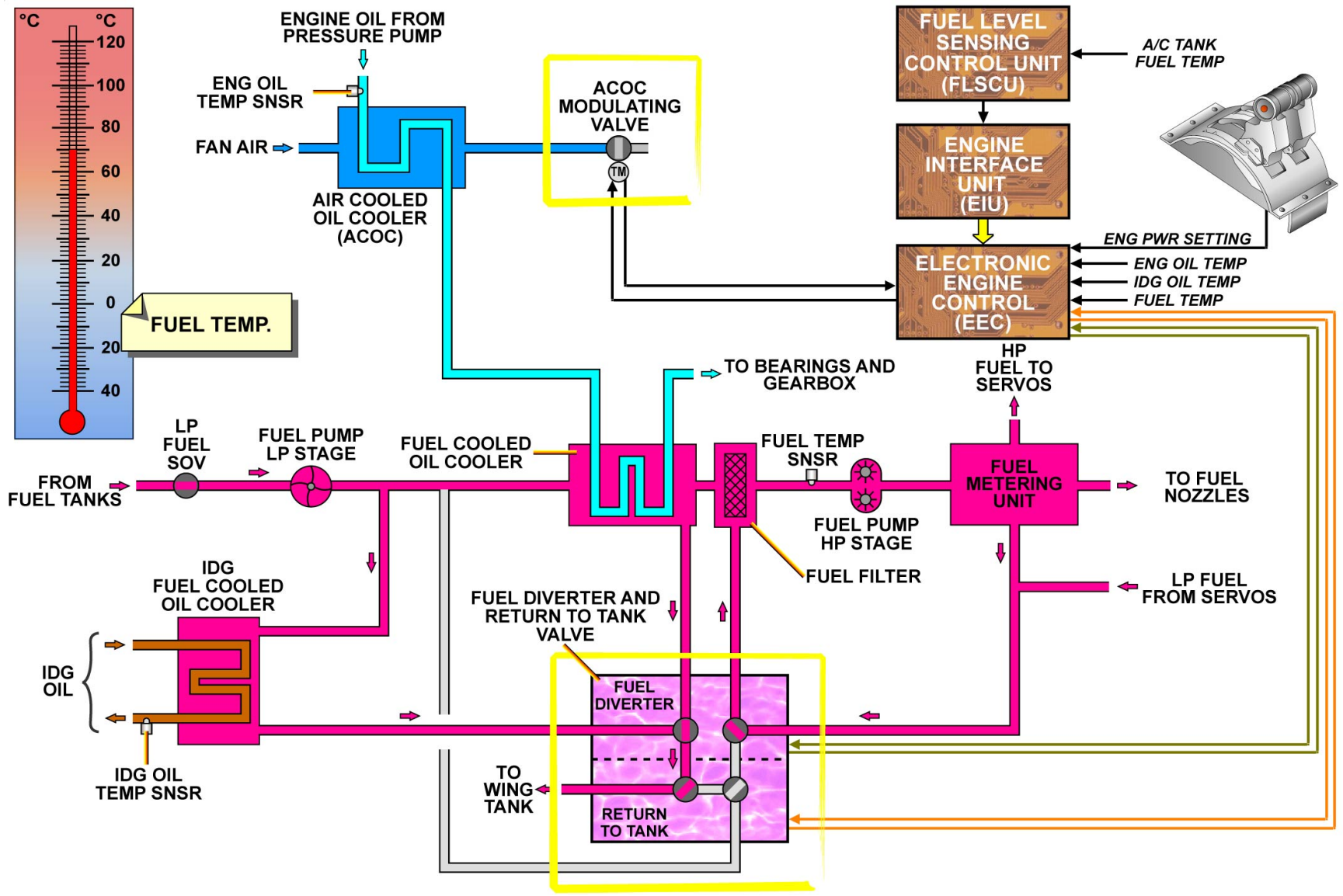

OPERATION - MODE 1

HEAT MANAGEMENT SYSTEM D/O (3)

OPERATION (continued)

MODE 4

Mode selected when in normal mode, i.e. mode 1, there is a high engine fuel temperature. To prevent an additional increasing of the fuel temperature, the engine oil is cooled by the Air Cooled Oil Cooler (ACOC). The ACOC modulating valve is controlled to fully open by the EEC.

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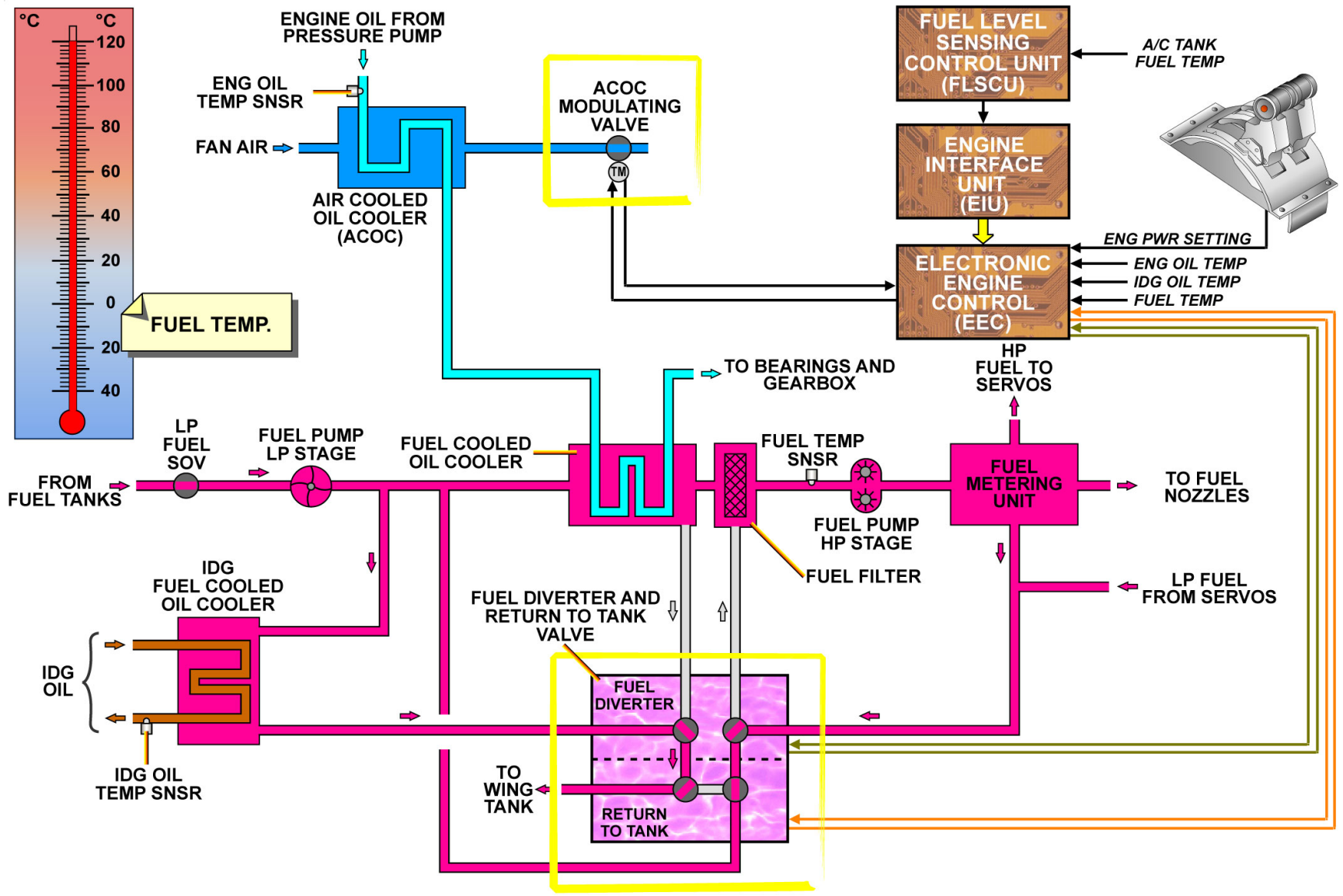

OPERATION - MODE 4

HEAT MANAGEMENT SYSTEM D/O (3)

OPERATION (continued)

MODE 3

Engine at high power setting: In this condition all the heat is absorbed by the burned fuel. If however the fuel flow is too low to provide adequate cooling the ACOC valve could be modulated. The fuel flow to the wing tank is stopped.

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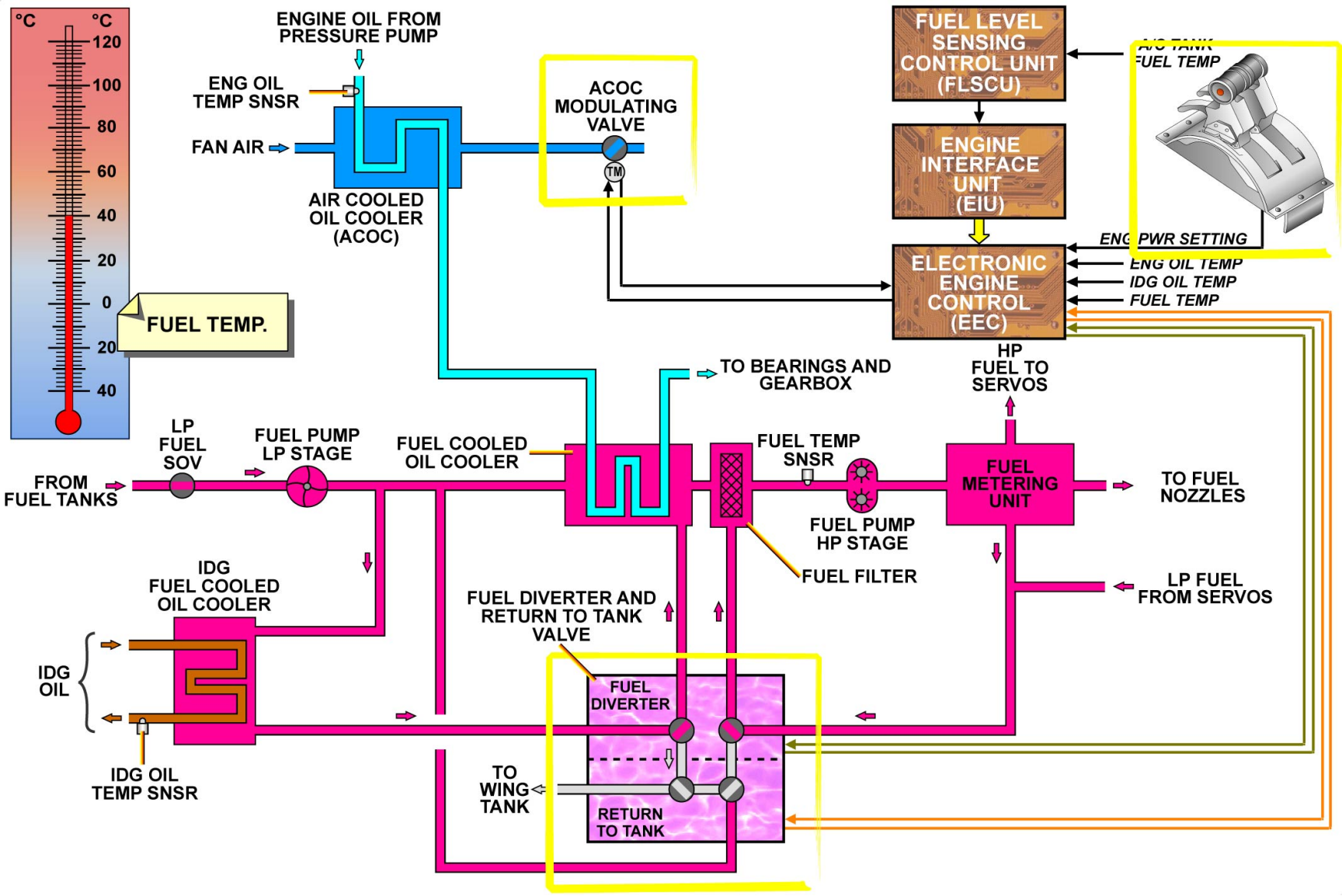

OPERATION - MODE 3

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HEAT MANAGEMENT SYSTEM D/O (3)

OPERATION (continued)

MODE 5

Mode selected when system condition demand as in mode 3 but this is not permitted because IDG oil temperature is excessive or return to tank is not permissible due to the high return fuel temperature. The ACOC valve is fully open.

NOTE: Note: This is the fail-safe mode of operation.

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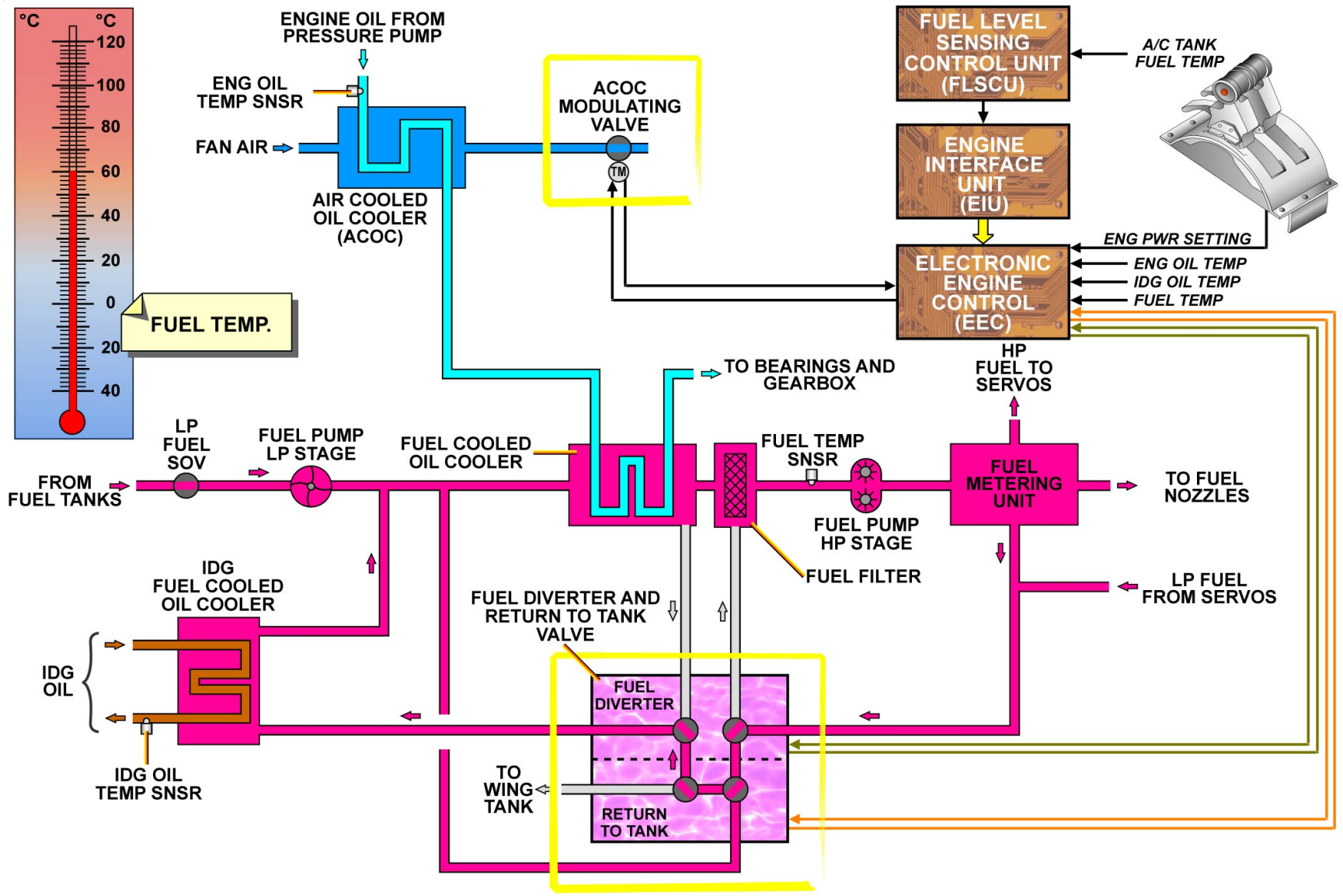


OPERATION - MODE 5

FADEC PRESENTATION (2)

PURPOSE

The Full Authority Digital Engine Control (FADEC) system provides full range engine control throughout all flight and operational phases. It consists of a dual channel Electronic Engine Control (EEC) and its peripheral components and sensors.

FADEC FUNCTIONS

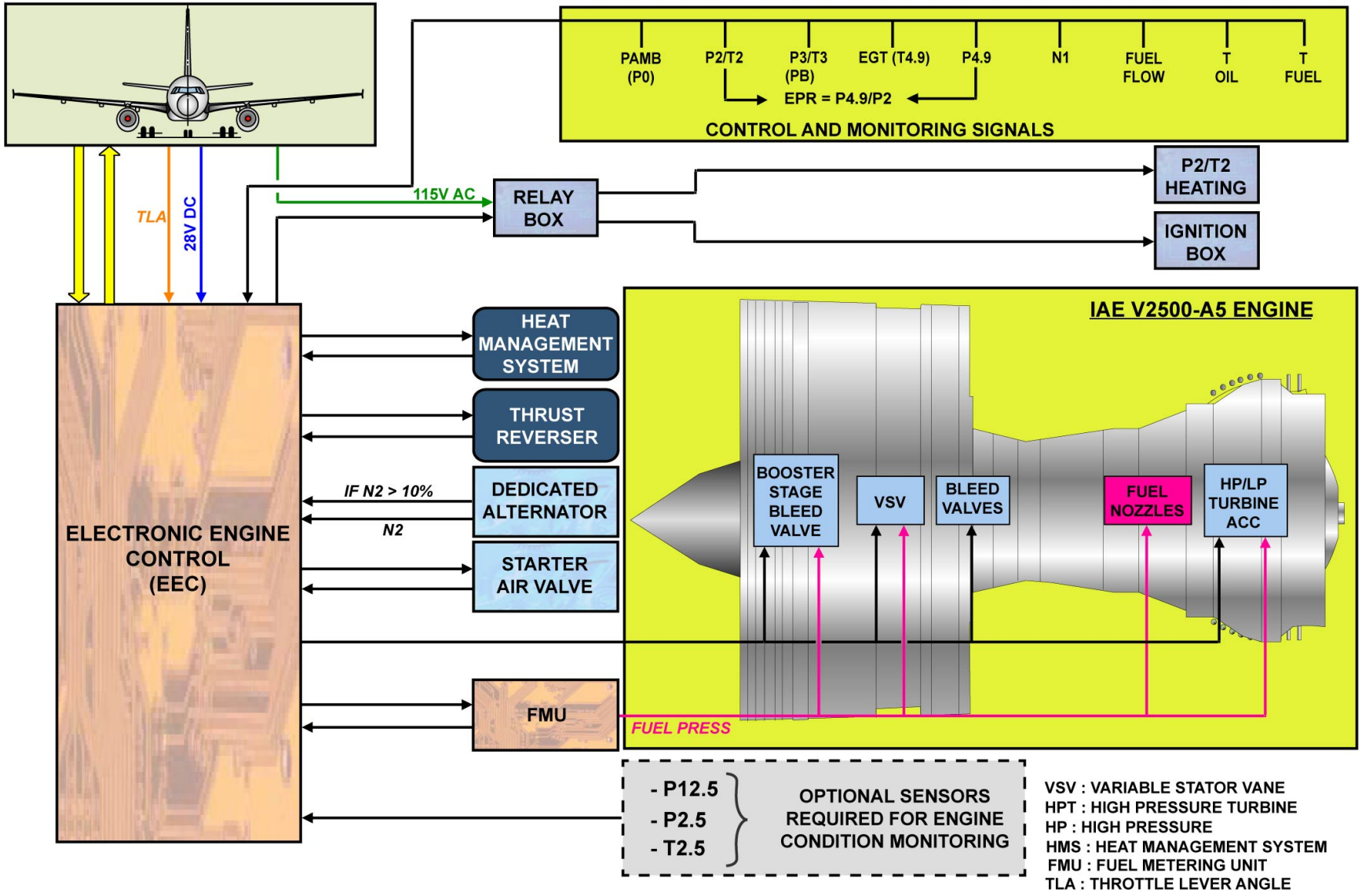
The FADEC provides the engine system regulation and scheduling to control the thrust and optimize the engine operation. The FADEC provides:
- power setting with EPR or N1 back-up mode,
- P2/T2 heating,
- acceleration and deceleration times,
- idle speed governing,
- overspeed limits for N1 and N2,
- Fuel Flow (FF) control,
- Variable Stator Vane system (VSV) control,
- compressor handling bleed valves control,
- booster stage bleed valve system control,
- High Pressure (HP)/Low Pressure (LP) turbine Active Clearance Control (ACC),
- automatic and manual engine starting,
- thrust reverser control,
- oil and fuel temperature management through the heat management system.

FADEC BENEFITS

The application of a FADEC system provides multiple benefits:
- it saves weight and fuel by a full range control of the gas generator,
- it reduces pilot workload and maintenance cost,
- it allows the optimum adaptation of thrust rating schedules to the A/C needs.

POWER SUPPLY

The FADEC system is self-powered by a dedicated Permanent Magnet Alternator (PMA) when N2 is greater than 10%. The EEC is powered by the aircraft 28 VDC electrical network for starting, as a backup and for testing with the engine not running. 115 VAC is used for the power supply of the ignition system and the P2/T2 probe heating. The PMA also provides the EEC Channel A and Channel B with the N2 rotation speed.



PURPOSE ... POWER SUPPLY

FADEC ARCHITECTURE (2)

DUAL CHANNEL

The Full Authority Digital Engine Control (FADEC) system is fully redundant and built around two independent control channels. Dual inputs, dual outputs and automatic switchover from one channel to the other eliminate any dormant failure. The Electronic Engine Control (EEC) consists of two channels A and B. Each channel can control the different components of the engine systems. Channels A and B are permanently operational. The channel in control manages the system.

DUAL INPUTS

All control inputs to the FADEC system are doubled. Only some secondary parameters used for monitoring and indicating are single. To increase the fault tolerant design, the parameters are exchanged between the two control channels inside the EEC via the cross channel data link.

HARDWIRED INPUTS

Most of the information exchanged between the A/C and the EEC is transmitted over digital data buses, some signals over a single line. In addition, some signals are hard-wired directly from the A/C to the EEC. The Throttle Lever Angle (TLA) is transformed by resolvers into a Throttle Resolver Angle (TRA) and transmitted directly to the EEC. 1° of TLA corresponds to 1.9° of TRA.

DUAL OUTPUTS

All the EEC outputs are double, but only the channel in control supplies the engine control signals to the various receptors such as torque motors and solenoids. The other channel calculation is used for crosschecking.

BITE CAPABILITY

The EEC is equipped with a BITE system which provides maintenance information and test capabilities via the MCDU.

FAULT STRATEGY

Using the BITE system, the EEC can detect and isolate failures. It also allows the EEC to switch engine control from the faulty channel to the healthy one. Depending on the nature of the failure, the EEC will behave differently in case of:
- single input signal failure, there is no channel changeover, the channel in control uses the inputs from the other channel through the cross channel data link,
- dual input signal failure, the system runs on synthesized values of the healthiest channel,
- single output signal failure, there is an automatic switchover to the standby active channel,
- complete output signal failure, there is no longer any current to drive the torque motors or solenoids, the related component will go to the "fail-safe" position.

FAIL-SAFE CONTROL

If a channel is faulty and the channel in control is unable to ensure one engine function, this control is moved to a fail-safe position. Example: if the channel is faulty and the remaining channel in control is unable to control the Variable Stator Vane (VSV) position, the vanes are set to the fail-safe open position.

MAIN INTERFACES

To perform all its tasks, the EEC interfaces with A/C computers, either directly or via the Engine Interface Unit (EIU), which is an interface

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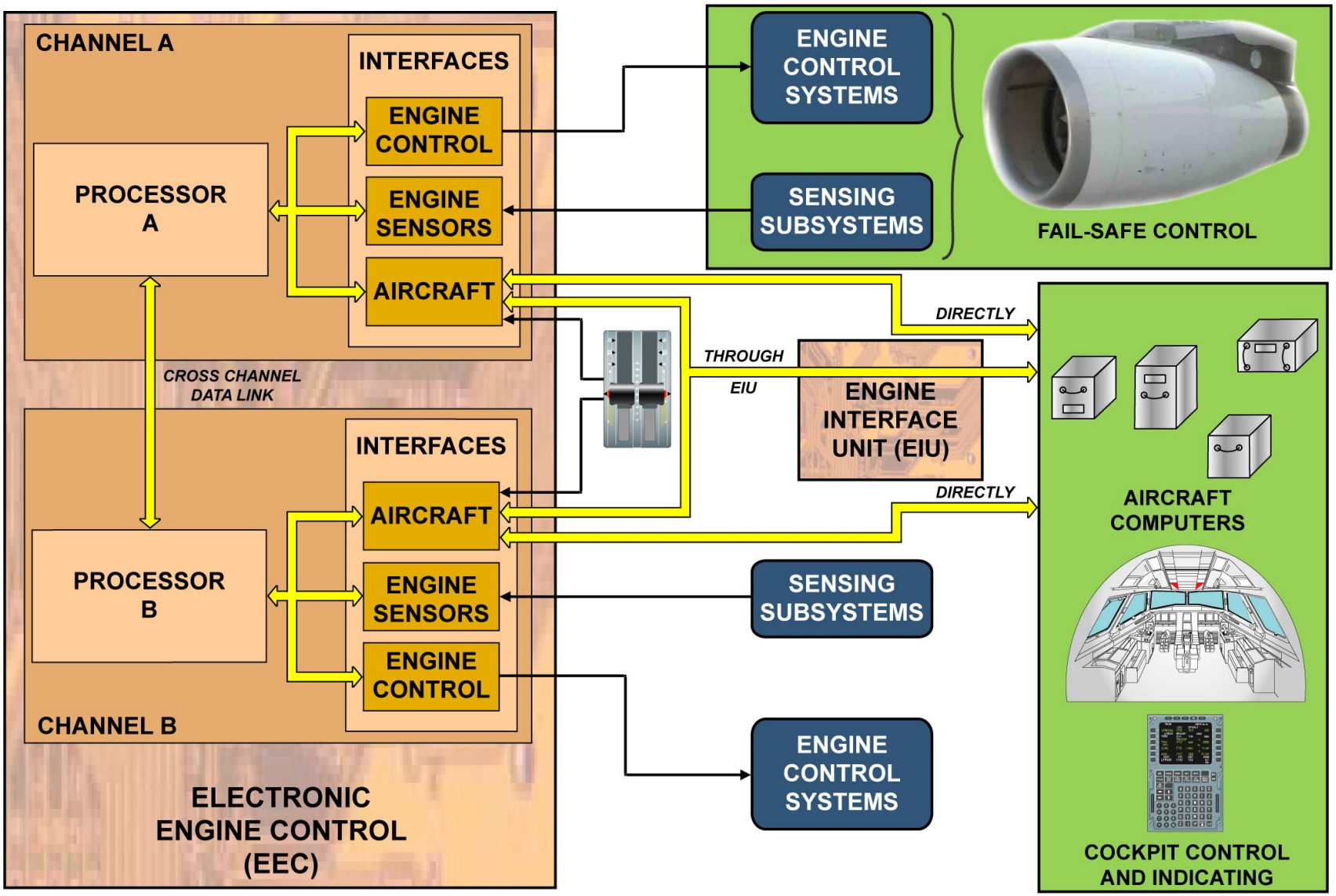
concentrator between the A/C systems and the FADEC system. There is one EIU for each engine, located in the avionics bay.

EEC INPUTS

The EEC receives inputs from:
- the Landing Gear Control and Interface Unit (LGCIU),
- the Air Data Inertial Reference Units (ADIRUs),
- the Flight Control Unit (FCU),
- the Environmental Control System (ECS) computers,
- the Centralized Fault Display Interface Unit (CFDIU),
- the cockpit engine controls including TRA, fire and anti-ice systems.

EEC OUPUTS

The EEC sends outputs to:
- the Bleed air Monitoring Computers (BMCs),
- the Electronic Control Box (ECB),
- the Flight Warning Computers (FWCs),
- the Display Management Computers (DMCs),
- the Flight Management and Guidance Computers (FMGCs),
- the CFDIU,
- the Data Management Unit (DMU), in option.



DUAL CHANNEL ... MAIN INTERFACES

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FADEC PRINCIPLE (2)

GENERAL

The Full Authority Digital Engine Control (FADEC) system manages the engine thrust and optimizes the performance.

FADEC

The FADEC consists of the Electronic Engine Control (EEC) and its peripheral components and sensors used for control and monitoring. The EEC is in relation with the other A/C systems through the Engine Interface Unit (EIU). The primary parameters Engine Pressure Ratio (EPR), Low Pressure Rotor Speed (N1), High Pressure Rotor Speed (N2), Exhaust Gas Temperature (EGT), and Fuel Flow (FF) are sent directly by the EEC to the ECAM.
Secondary parameters:
- the oil quantity and oil pressure are sent to the DMCs by the SDACs. In case of SDACs failure, the EIU sends data to DMCs by the FWCs,
- the oil temperature is sent by the EIU to DMCs via thhe FWCs,
- the fuel used data is directly sent to DMCs via the EEC,
- the vibration parameters are sent by the EIVMU to DMCs via the SDACs.

EIU

Each EIU, located in the avionics bay, is an interface concentrator between the airframe and the corresponding FADEC located on the engine. There is one EIU for each engine.

POWER MANAGEMENT

The FADEC provides automatic engine thrust control and thrust parameter limit computation. The thrust is computed according to the Engine Pressure Ratio (EPR) in normal mode or N1 in back-up mode. In fact, when the Engine Pressure Ratio (EPR) mode is no longer operational the FADEC automatically reverts to the N1 alternate control mode. The FADEC manages power according to two thrust modes:
- manual mode depending on the Throttle Resolver Angle (TRA),
- auto thrust mode depending on the auto thrust function generated by the Auto Flight System (AFS).
The FADEC also provides two idle mode selections:
- approach idle,
- minimum idle.
Approach idle is obtained when the slats are extended. Minimum idle can be modulated up to approach idle depending on air conditioning, engine anti-ice and wing anti-ice demands.

ENGINE LIMITS

The FADEC provides overspeed protection for N1 and N2, in order to prevent the engine from exceeding limits, and also monitors the EGT and Engine Pressure Ratio (EPR).

ENGINE SYSTEMS

The FADEC provides optimal engine operation by controlling the:
- FF,
- compressor airflow and turbine clearance.

IGNITION AND STARTING

The FADEC controls the engine start sequence. It monitors N1, N2, and EGT parameters and can abort or recycle an engine start. The FADEC controls the ignition and starting in automatic or manual mode when initiated from the ENGine start or ENGine MANual START panels.

THRUST REVERSER

The FADEC supervises the thrust reverser operation entirely.

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NOTE: Note: during reverse operation the thrust is controlled as a function of N1.

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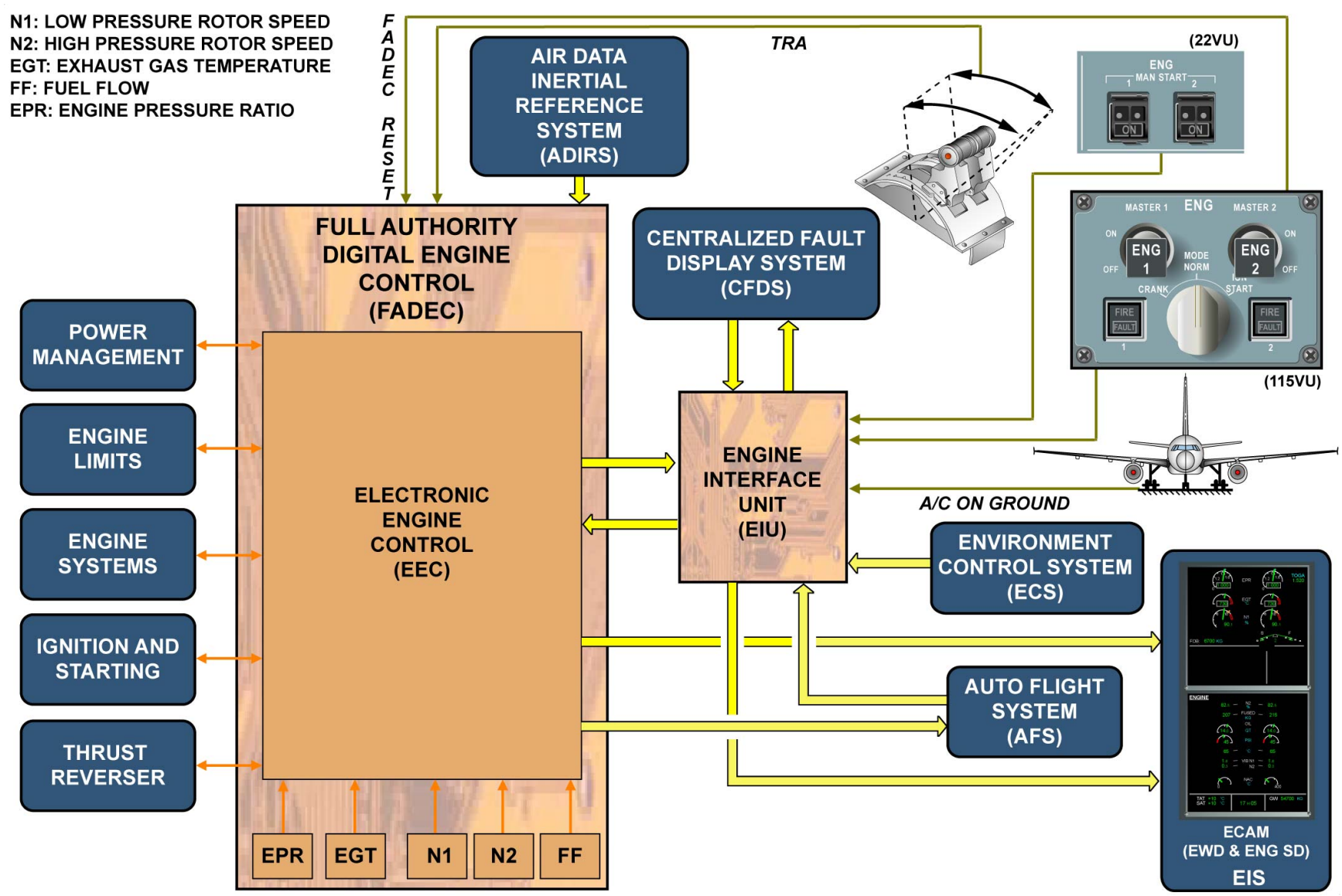

GENERAL ... THRUST REVERSER

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EEC INTERFACES (3)

GENERAL

In order to provide a full range of engine control and monitoring, the Electronic Engine Control (EEC) interfaces with the following sub systems:
- air data computers, which transmit air data for engine control,
- Engine Interface Unit (EIU), which concentrates A/C signals and transmits them to the EEC,
- for cockpit indication and control, and autothrust control, the EEC sends signals to computers,
- engine sensors and controls.

DIGITAL INPUTS

Inputs of each channel are isolated in order to prevent failure propagation. Each channel receives inputs for both the Air Data/Inertial Reference Units (ADIRUs) and the EIU. The EEC performs a fault detection on its input parameters by determining if they are valid. This check is made by applying a range of tests to each input. Faults detected by the EEC are annunciated and recorded for maintenance or crew action, if required. The ADIRUs send air data parameters to the EEC for engine control. The EEC performs validation tests and selection logic between air data signals from the ADIRUs and the engine sensors. ADIRU data is preferred over engine data. The air data used to validate Altitude (P0), Total Air Temperature (TAT), TOTal PRESSure, mach for the power management and engine controls are:
- TAT, TOTal PRESSure, P0, mach number, from the ADIRUs,
- P2, T2 and P0 from engine sensors.

DIGITAL OUTPUTS

Each channel has 2 output ports and each bus has a separated line driver, i.e. A1, A2, B1, B2, in such a way that propagation of failures is prevented. The EEC output buses provide:
- engine control parameters,
- engine condition monitoring parameters,
- EEC status and fault indication,
- engine rating parameters,
- Full Authority Digital Engine Control (FADEC) system maintenance data.

The EEC transmits outputs continuously on all buses in normal operation, irrespective of whether the given channel is in active control or not. The parameter values on the 2 output buses are normally identical as long as the cross channel data link is functioning.

NOTE: Channel switchover does not affect the output data of the EEC.

DISCRETE/ANALOG SIGNALS

The EEC receives the Throttle Resolver Angle (TRA) signals, the autothrust instinctive disconnect switch signals and engine sensor signals. They are validated by the EEC. The EEC also sends signals to the engine controls. The resolvers of the Throttle Control Unit (TCU) receive an excitation current from the EEC. The EEC checks the range limits, the rate limits and performs an interface fault detection test.

NOTE: 1 degree TLA corresponds to 1.9 degree TRA.

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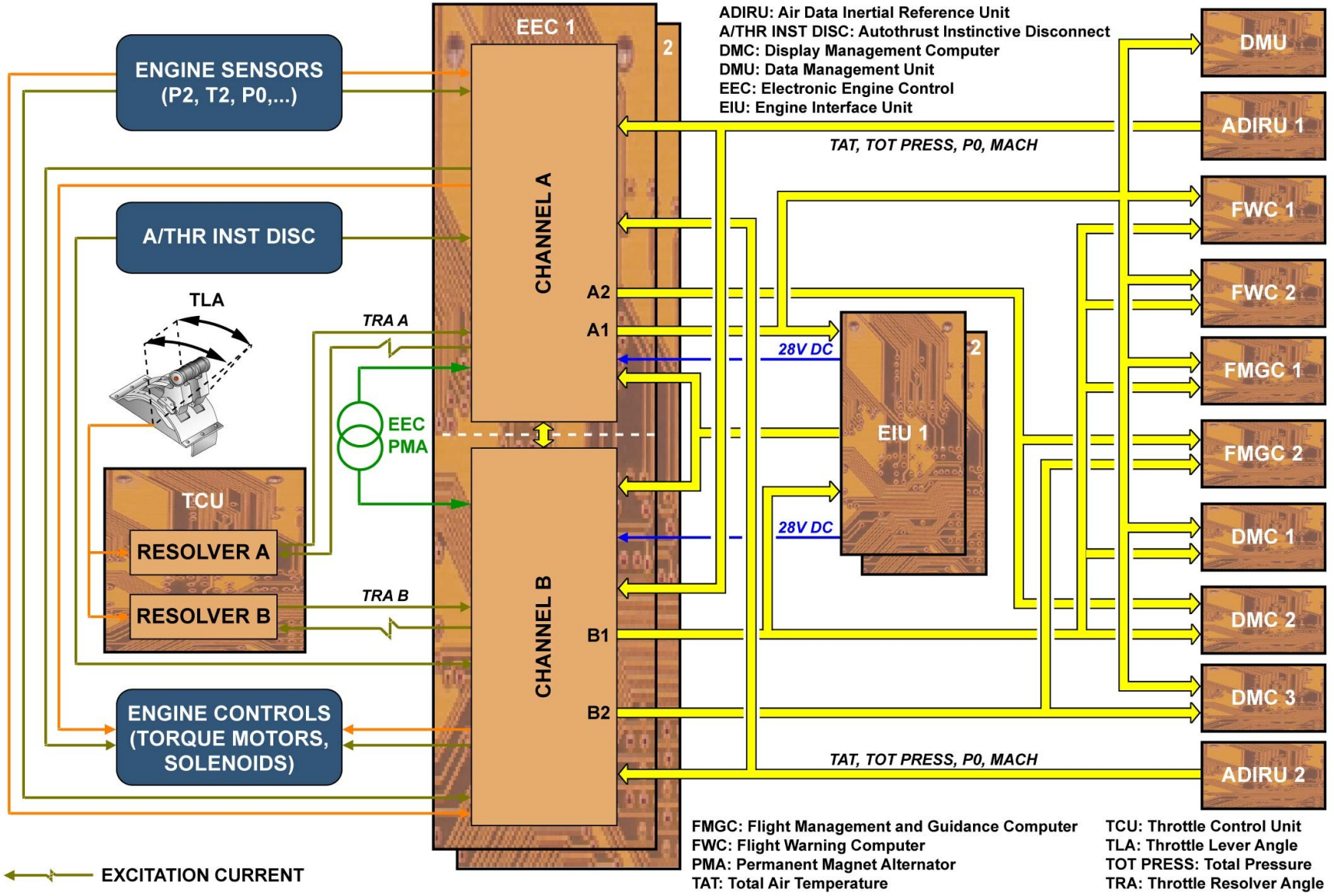

GENERAL ... DISCRETE/ANALOG SIGNALS

EEC INTERFACES (3)

BLOCK DIAGRAM

Here are the interfaces between the EEC and the A/C in the form of a block diagram.

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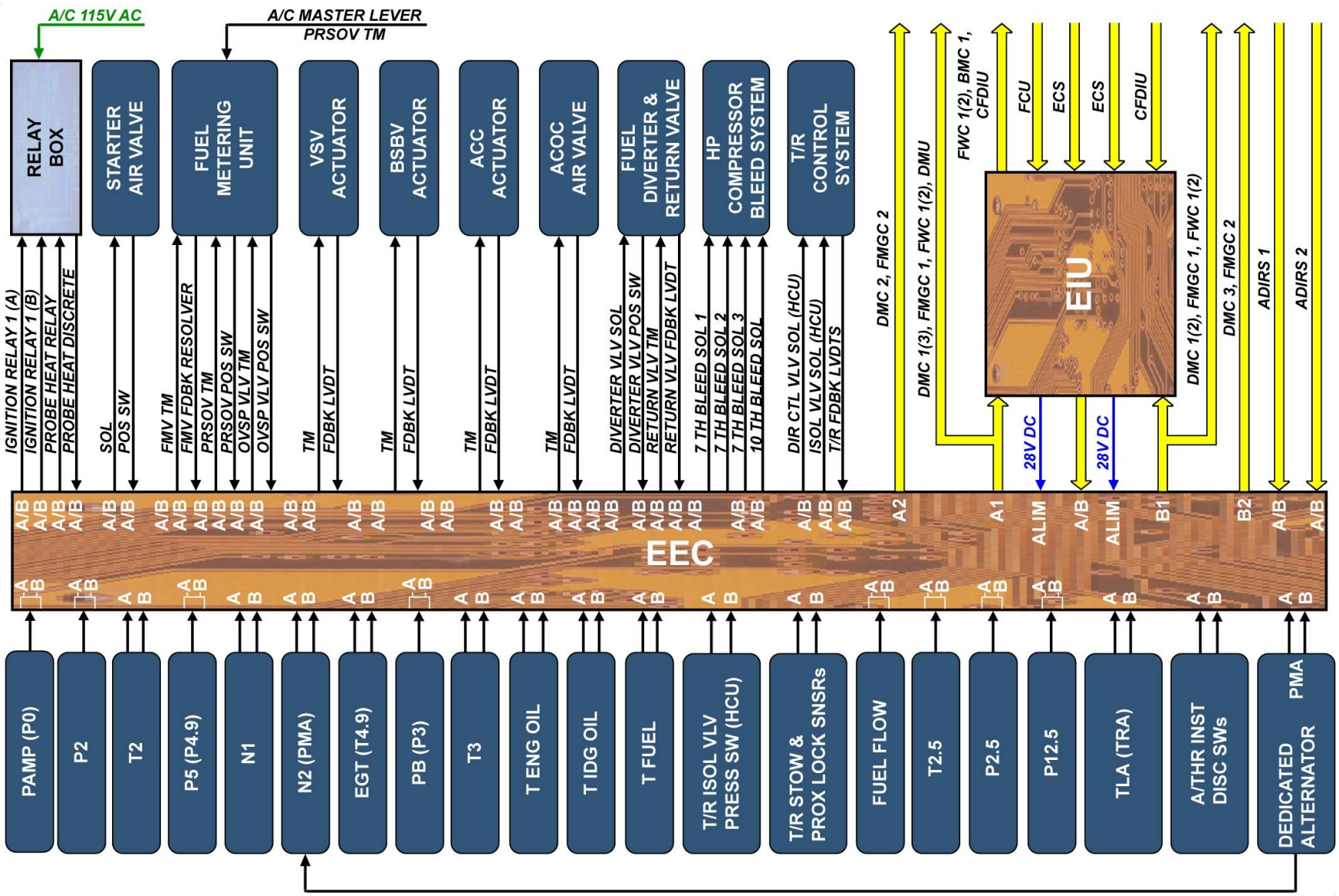


BLOCK DIAGRAM

UGB13131 - U7ST0M0 - UM73D7IAE000001

EIU INTERFACES (3)

GENERAL

There are 2 Engine Interface Units (EIUs), one for each engine. The EIU is an interface concentrator between the A/C and the Full Authority Digital Engine Control (FADEC) system. The main functions of the EIU are:
- to concentrate data from the cockpit panels,
- to ensure the segregation of the 2 engines,
- to provide the Electronic Engine Control (EEC) with an electrical power supply,
- to give the necessary logic and information from the engine to the aircraft systems.

EIU COMPOSITION

The EIU is composed of 5 main parts:
- discrete and analog inputs,
- digital inputs,
- digital outputs,
- discrete outputs,
- power supply switching.

EIU FUNCTIONS

The EIU performs the following:
- acquisition of information,
- transmission of messages,
- logics for Low Oil Pressure (LOP) and Auxiliary Power Unit (APU) boost,
- fault detection logic carried out by an internal BITE and transmission of the result to the Centralized Fault Display System (CFDS).

INPUTS

The EIU receives the following:
- discrete signals which are of the ground/open circuit type,
- analog inputs which are of the differential type with a working range of 1 to 9 volts,
- digital inputs on ARINC 429 lines.

OUTPUTS

The EIU sends the following:
- digital output signals on ARINC 429 buses,
- discrete signals which are of the 28V DC/open circuit or ground/open circuit types.

EEC INTERFACE

The EIU receives 2 ARINC 429 output data buses from EEC channels A and B and it uses data from the channel in control. If some data is not available from the control channel, data from the other channel is used. The EIU looks at particular engine data on the EEC digital data flow to interface this with other aircraft computers and with cockpit panels for control and monitoring. The EIU sends information, coming from all aircraft computers, which have to communicate with the EEC, through an output ARINC 429 data bus. The EIU does not deal with Air Data/Inertial Reference Unit (ADIRU) and thrust lever information as they communicate directly with the EEC.

NOTE: Note: There is no data flow during the EIU internal test or initialization.

ECS INTERFACE

The EIU receives two inputs from the Air Conditioning System Controller (ACSC) 1 and 2 of the Environmental Control System (ECS).
The ECS determines the various air bleed configurations according to logics of the air conditioning, wing anti-ice and nacelle anti-ice. This information is transmitted by the EIU to the EEC to compute the bleed air demand required at the engine customer bleed ports.

ENGINE START CONTROL

The EIU receives and generates all starting signals from the cockpit engine panels. Therefore engine starting is not possible in case of EIU failure. The control panels provide the EIU with the following signals:
- engine start mode selector position,
- master lever position,
- manual start P/B.

The EIU provides all starting signals to the EEC and to the ENGine start panel FAULT light.

CFDS INTERFACE

The Centralized Fault Display Interface Unit (CFDIU) communicates with the BITE memory of the EIU and with the BITE memory of the EEC via the EIU. The EIU interfaces with the CFDIU to generate the EIU and the FADEC fault messages on the MCDU. To access the FADEC menu function, the CFDS interrogates the EEC BITE memory through the EIU.

BMC INTERFACE

There is an interface between the EIU and the pneumatic system Bleed Monitoring Computer (BMC) for engines 1 and 2. During engine start, the EIU generates a ground signal for the BMC when the start valve moves away from the closed position. On receipt of this ground signal, the BMC closes the pneumatic system Pressure Regulating Valve (PRV).

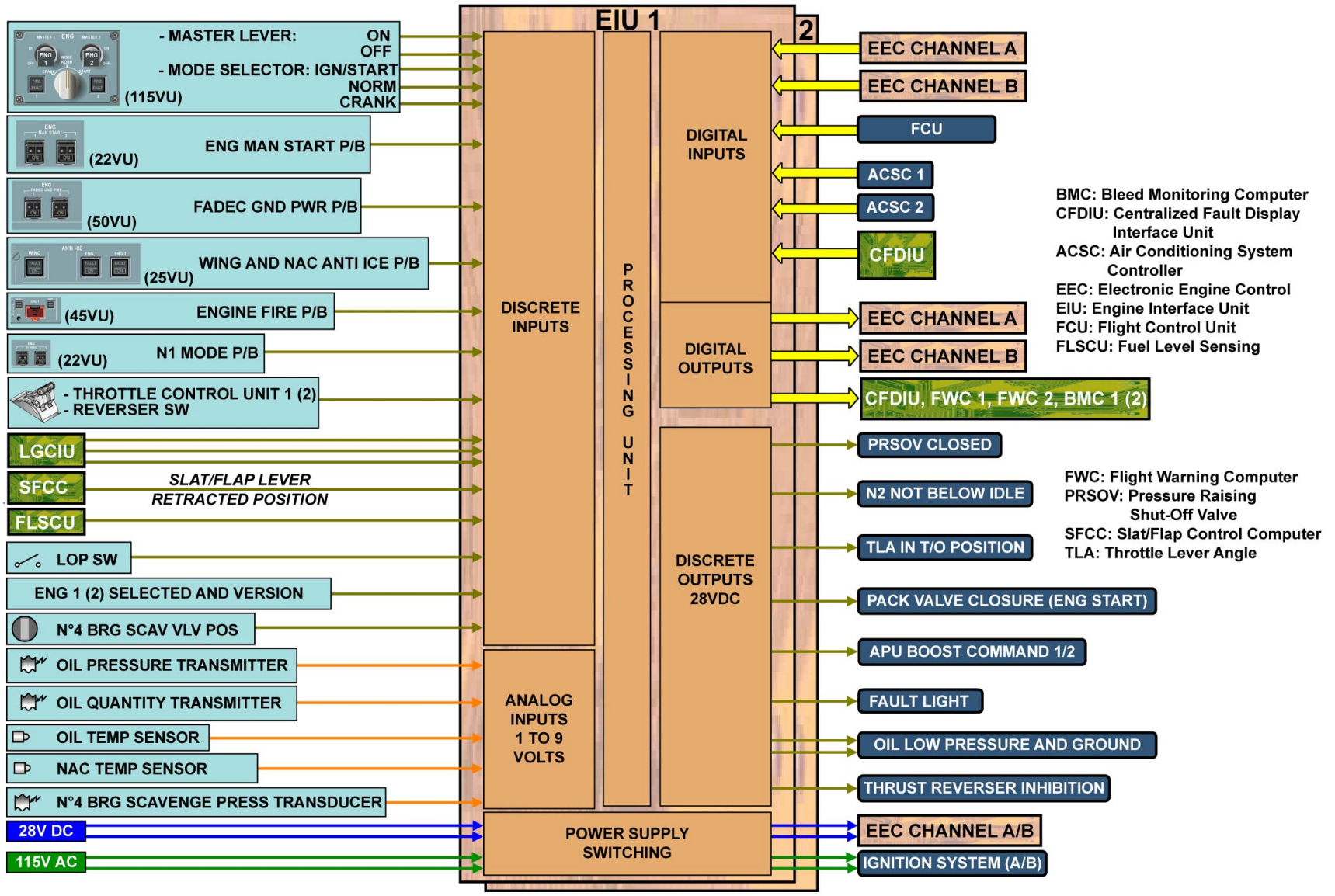
OTHER INTERFACES

The EIU also receives other signals from various aircraft systems for control and monitoring purposes. The EIU also generates signals for various aircraft systems.

POWER SUPPLY

The EIU receives the following:
- 28V DC for its own power supply and for the FADEC power supply,
- 115V AC for engine ignition system power supply.

NOTE: Note: In case of EIU failure, the power supply for FADEC and ignition is preserved (fail safe position).



GENERAL ... POWER SUPPLY

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EIU INTERFACES (3)

FMGS

The AutoTHRust (A/THR) function is provided by the Flight Management and Guidance System (FMGS). Therefore, the FMGS sends all command signals for engine power management via the Flight Control Unit (FCU) and both EIUs. The FMGS assumes the following functions:
- computation of Engine Pressure Ratio (EPR) target,
- selection of A/THR modes,
- alpha floor protection,
- flexible takeoff,
- A/THR engagement.

FEEDBACK

The EEC directly sends specific feedback outputs to the FMGS without going through the EIU. The EIU also receives this data but does not transmit it to FMGS. The EEC feedback output data to Flight Management and Guidance Computer (FMGC) is as follows:
- Thrust Resolver Angle (TRA),
- EPR command,
- EPR actual,
- EPR target in feedback,
- EPR limit,
- EPR max,
- EPR reference throttle,
- thrust mode,
- Fuel Flow (FF),
- bleed configuration in feedback,
- engine rating identification,
- flexible temperature in feedback.

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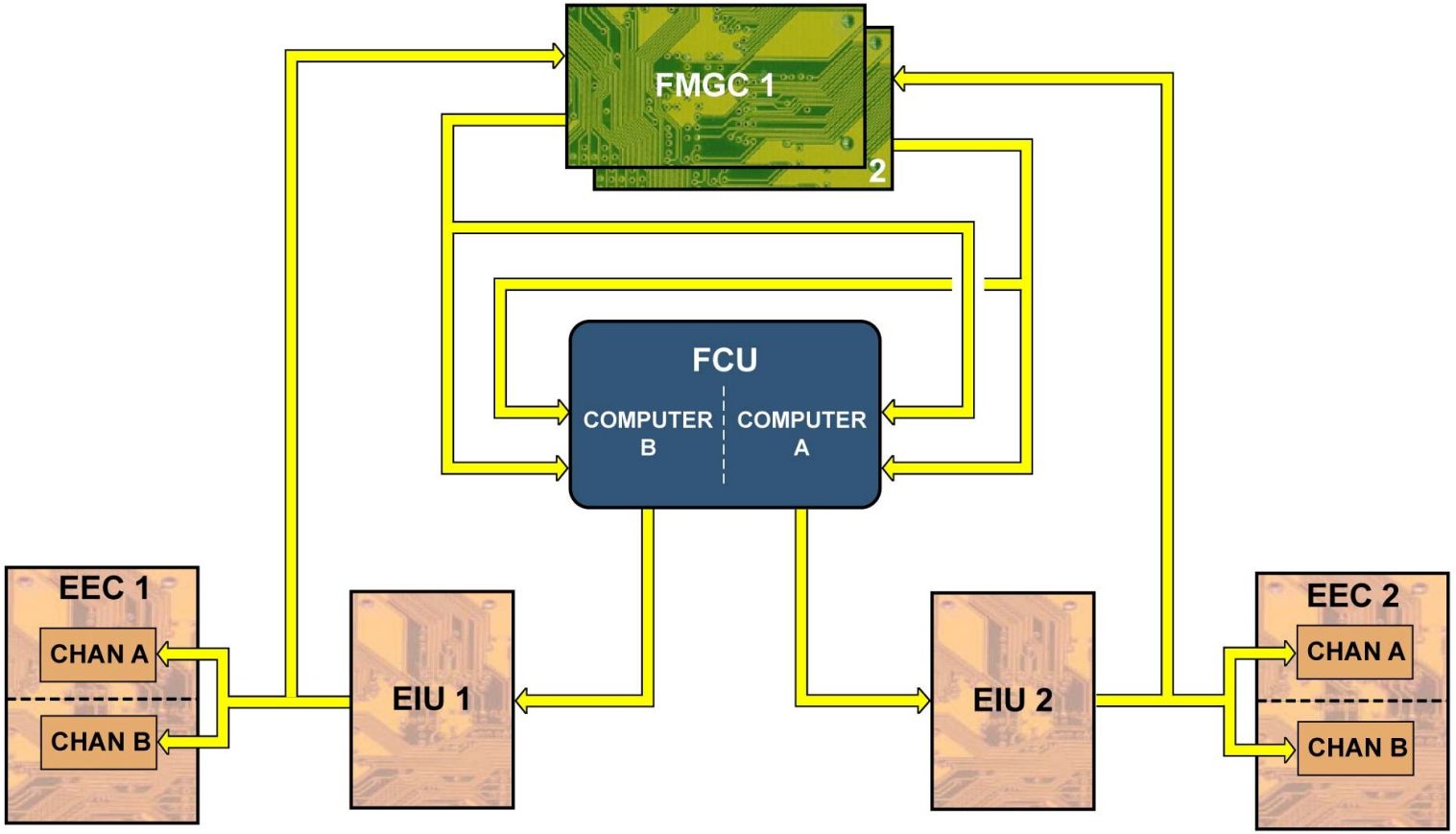


EEC: Electronic Engine Control
EIU: Engine Interface Unit
FCU: Flight Control Unit
FMGC: Flight Management and Guidance Computer

FMGS - FEEDBACK

EEC ELECTRICAL PWR SPLY CONTROL (3)

GENERAL

The Electronic Engine Control (EEC) is electrically supplied by:
- the A/C network when High Pressure Rotor Speed (N2) is below 10% or when the dedicated alternator has failed,
- the dedicated alternator when N2 is above 10%.

POWERING N2 < 10%

The EEC is supplied by the A/C electrical power network when N2 is below 10%. Each channel is independently supplied by the A/C 28V DC through the Engine Interface Unit (EIU). The aircraft 28V DC permits:
- automatic ground check of the Full Authority Digital Engine Control (FADEC) system before the engine is running, that is to say FADEC GrouND PoWeR ON,
- engine starting: MASTER lever ON or mode selector on IGNition or CRANK,
- powering the EEC while the engine reaches 10% of N2.

NOTE: Note: the EIU takes its power from the same bus bar as the EEC.

POWERING N2 > 10%

As soon as the engine is running above 10% of N2, the dedicated alternator directly supplies the EEC. The dedicated alternator supplies each channel with three-phase AC power. Two transformer rectifiers provide 28V DC power supply to channels A and B. Switching between the A/C 28V DC supply and the dedicated alternator power supplies is done automatically by the EEC.

AUTO DEPOWERING

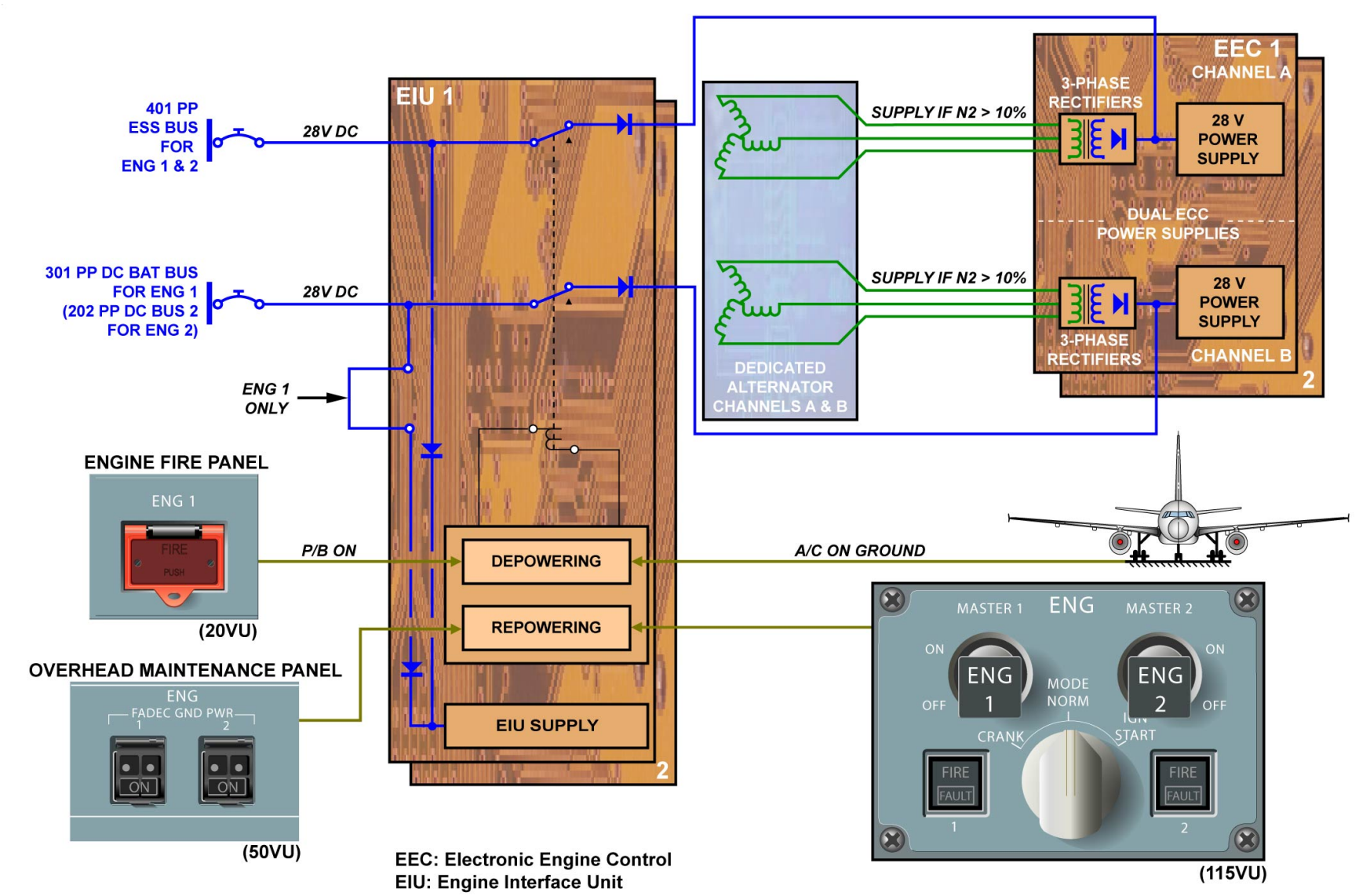
The FADEC is automatically depowered on the ground, through the EIU, after engine shutdown. EEC automatic depowering occurs on the ground:
- 5 min after A/C power-up,
- 5 min after engine shutdown.

NOTE: Note: An action on the ENGine FIRE P/B provides EEC power cut-off from the A/C network.

MANUAL REPOWERING

For maintenance purposes and MCDU engine tests, the ENGine FADEC GrouND PoWeR panel permits FADEC power supply to be restored on the ground with engines shut down. When the corresponding ENGine FADEC GrouND PoWeR P/B is pressed ON the EEC recovers its power supply.

NOTE: Note: The FADEC is also repowered as soon as the engine start selector is in IGNition/START or CRANK position, or the MASTER lever is selected ON.



GENERAL ... MANUAL REPOWERING

IGNITION & STARTING SYSTEM PRESENTATION (2)

GENERAL

The ignition system provides the electrical spark needed to start or continue engine combustion. The ignition system is made up of two independent subsystems energized by a relay box. Each subsystem includes an ignition exciter, a coaxial shield ignition lead and an igniter plug. The pneumatic starting system drives the engine High Pressure (HP) rotor at a speed high enough for a ground or in flight start to be initiated. The start system is made up of the start valve and the starter.

CONTROL AND INDICATING

The Electronic Engine Control (EEC) controls the ignition through the relay box and starting through the start valve, either in automatic or manual mode. The operation of the start valve and of the ignition system is displayed on the ENGINE ECAM page.

AUTOMATIC START

During an automatic start, the EEC opens the start valve, then the ignition exciter is energized when the HP rotor speed is nominal. The EEC provides full protection during the start sequence. When the automatic start is completed, the EEC closes the start valve and cuts off the ignition. In case of an incident during the automatic start the EEC aborts the start procedure.

MANUAL START

During a manual start, the start valve opens when the engine MANual START P/B is pressed in, then the ignition system is energized when the MASTER control lever is set to the ON position.

NOTE: there is no automatic shutdown function in manual mode.

CRANKING

Engine motoring could be performed for dry cranking or wet cranking sequences.

NOTE: during cranking ignition is inhibited.

CONTINUOUS IGNITION

With engine running, continuous ignition can be selected via the EEC either manually using the rotary selector or automatically by the Full Authority Digital Engine Control (FADEC).

SAFETY PRECAUTIONS

Safety precautions have to be taken prior to working in this area.

WARNING: THE EEC AND THE RELAY BOX SEND 115 VOLTS TO THE IGNITION BOXES, WHICH CONVERT IT AND SEND HIGH ENERGY PULSES THROUGH THE IGNITION LEADS TO THE IGNITERS PLUGS.

MAINTENANCE PRACTICES

To increase A/C dispatch, the start valve is equipped with a manual override. For this manual operation, the mechanic has to be aware of the engine safety zones.

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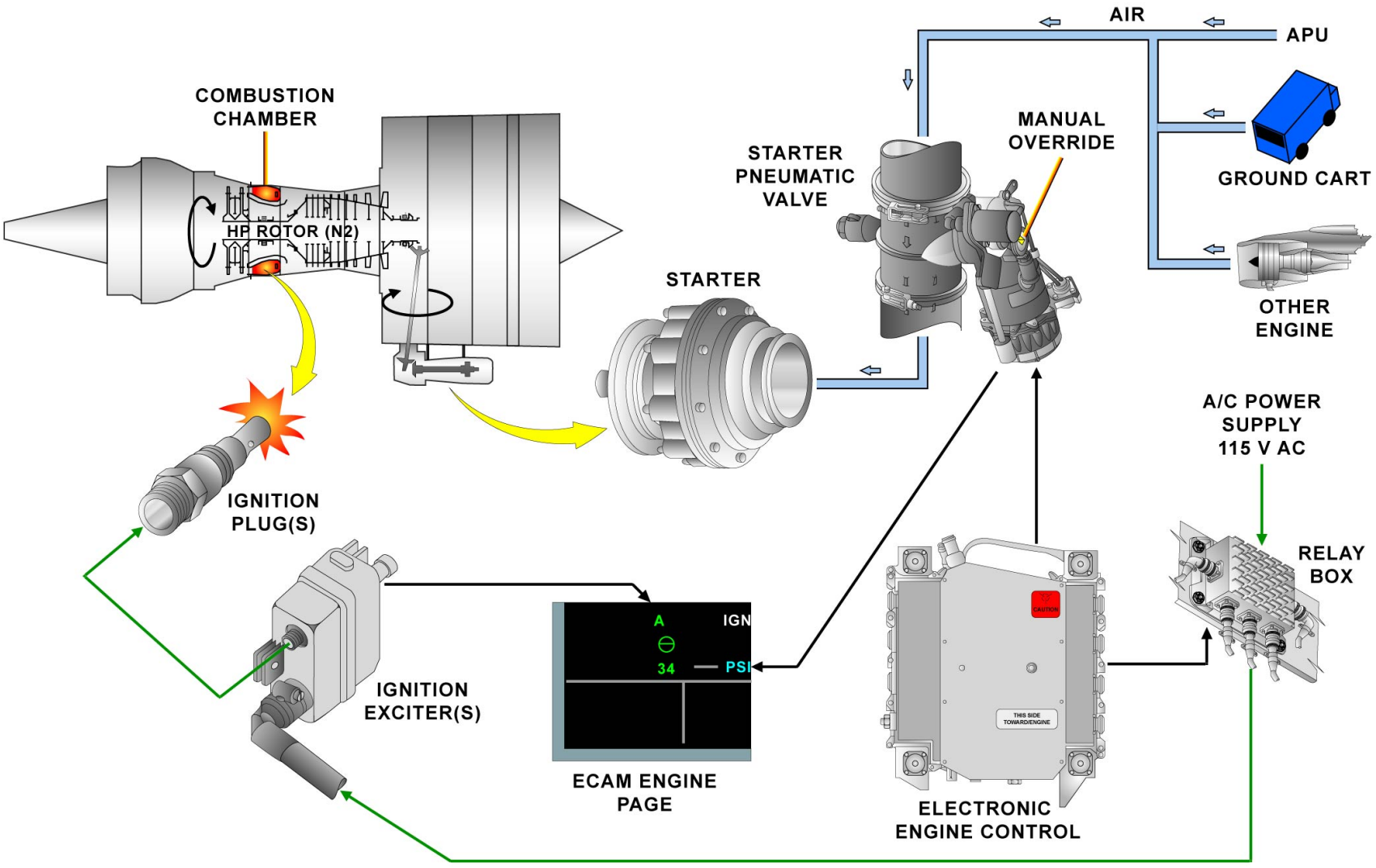

GENERAL ... MAINTENANCE PRACTICES

IGNITION & STARTING SYSTEM D/O (3)

GENERAL

The Electronic Engine Control (EEC) controls and monitors the start sequence either in automatic or in manual mode.
The start sequence is aborted below 50% N2 in case of:
- starter valve failure,
- ignition failure,
- pressure raising Shut-Off Valve (SOV) failure,
- hot start,
- hung start,

The system consists of a starter valve, a pneumatic starter, a relay box, two ignition exciters and igniters A and B. The starter valve is fitted with a manual override for mechanic operation on ground.

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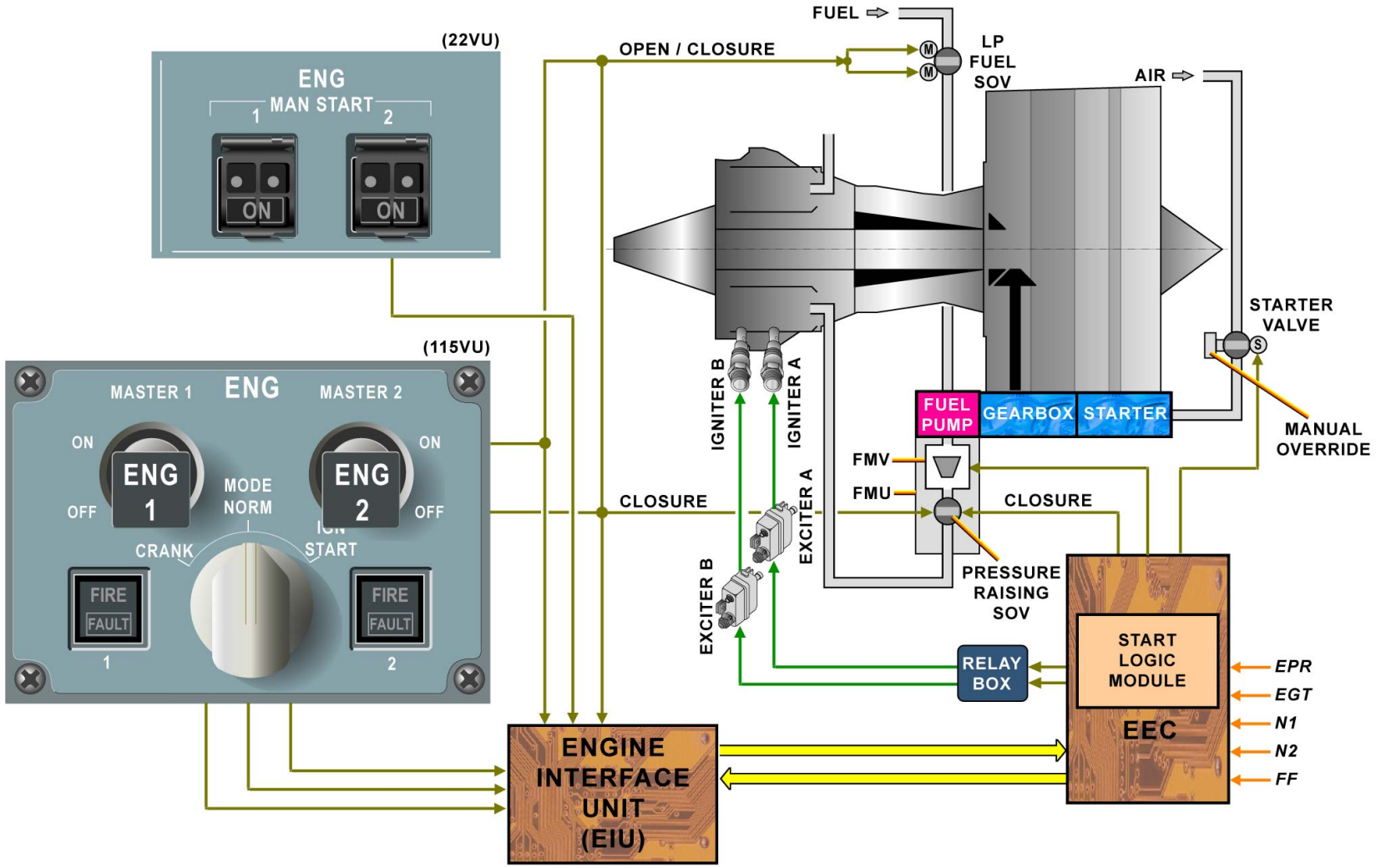
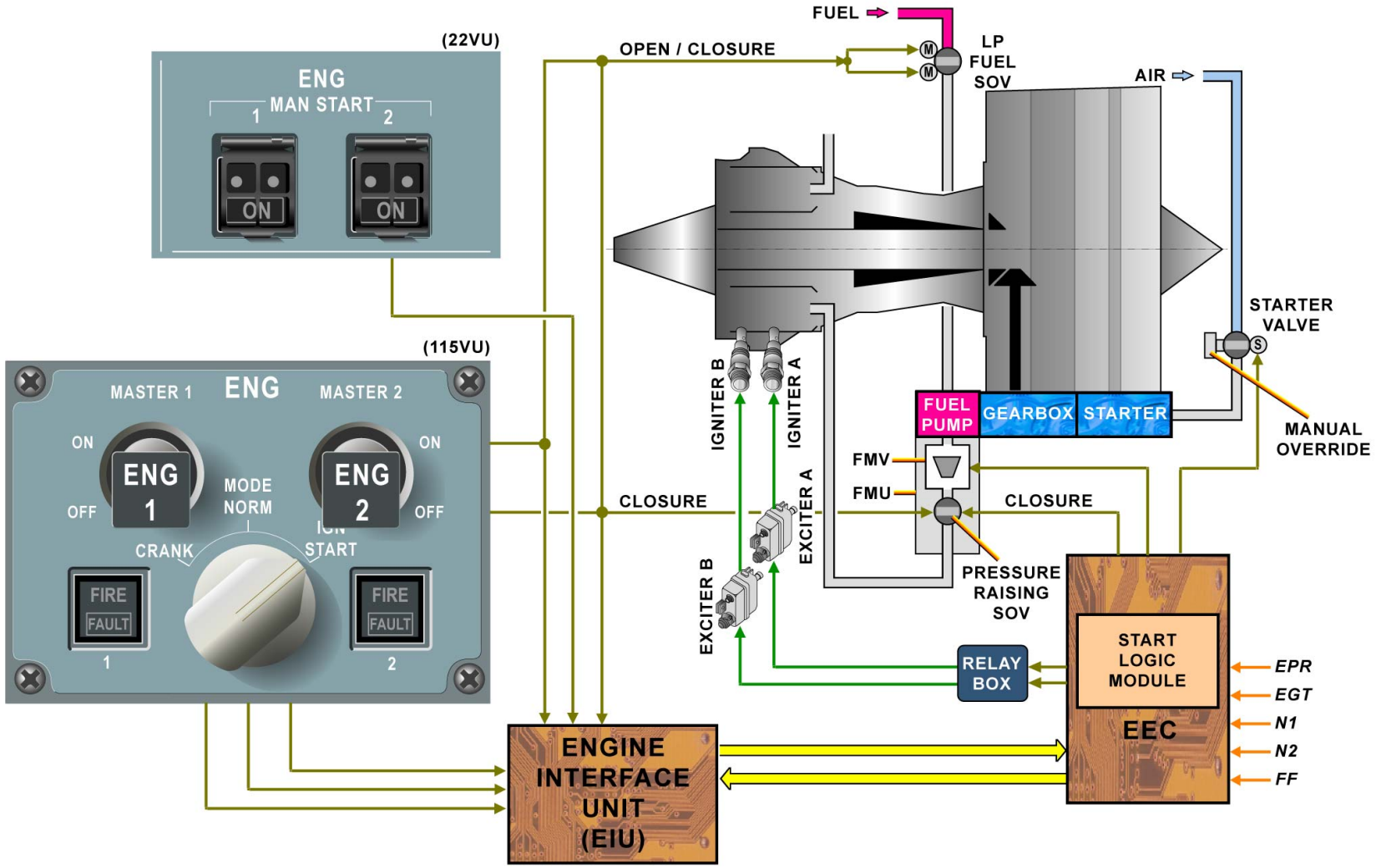

(22VU)
ENG
MAN START
1
2
ON
ON
(115VU)
MASTER 1
ENG
MASTER 2
ON
ENG
1
OFF
MODE
NORM
ENG
2
ON
OFF
CRANK
START
FIRE
FAULT
1
FIRE
FAULT
2
FUEL
OPEN / CLOSURE
LP
FUEL
SOV
AIR
STARTER
VALVE
MANUAL
OVERRIDE
IGNITER B
IGNITER A
FUEL
PUMP
GEARBOX
STARTER
FMV
FMU
CLOSURE
CLOSURE
EXCITER A
EXCITER B
PRESSURE
RAISING
SOV
RELAY
BOX
START
LOGIC
MODULE
EEC
EPR
EGT
N1
N2
FF
ENGINE
INTERFACE
UNIT
(EIU)

GENERAL

IGNITION & STARTING SYSTEM D/O (3)

AUTO START

In aircraft configuration, the APU is running and APU bleed air is available. When the MODE selector is set to IGNition START, the EEC is armed for the start sequence. After checking indications and obtaining Ground Clearance, set the ENG/MASTER control switch to ON.


(22VU)
ENG
MAN START
1
2
ON
ON
(115VU)
MASTER 1
ENG
MASTER 2
ON
ENG
1
OFF
MODE
NORM
ON
ENG
2
OFF
CRANK
START
FIRE
FAULT
1
FIRE
FAULT
2
FUEL
OPEN / CLOSURE
LP
FUEL
SOV
AIR
STARTER
VALVE
MANUAL
OVERRIDE
IGNITER B
IGNITER A
FUEL
PUMP
GEARBOX
STARTER
FMV
FMU
CLOSURE
CLOSURE
EXCITER A
EXCITER B
PRESSURE
RAISING
SOV
RELAY
BOX
START
LOGIC
MODULE
EEC
EPR
EGT
N1
N2
FF
ENGINE
INTERFACE
UNIT
(EIU)

AUTO START

IGNITION & STARTING SYSTEM D/O (3)

AUTO START (continued)

MASTER SWITCH ON

As soon as the MASTER switch is set to ON, the Low Pressure (LP) fuel SOV opens and the EEC opens the starter valve:
- N2 increases,
o the pressure raising and SOV solenoid is de-energized because the MASTER switch is ON.
o Then the EEC provides ignition, which is automatically selected by the EEC and displayed on the ECAM ENGINE page.

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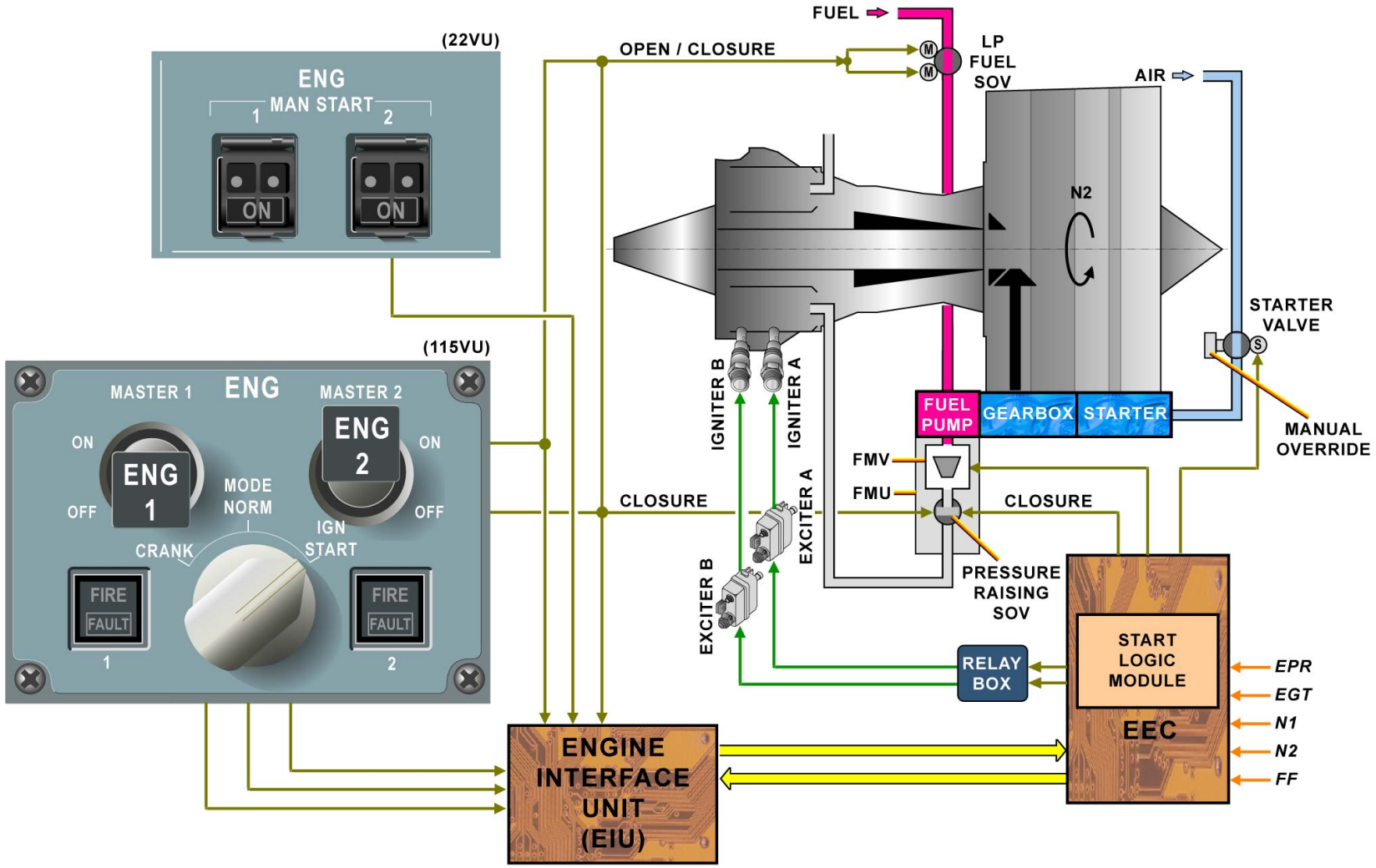


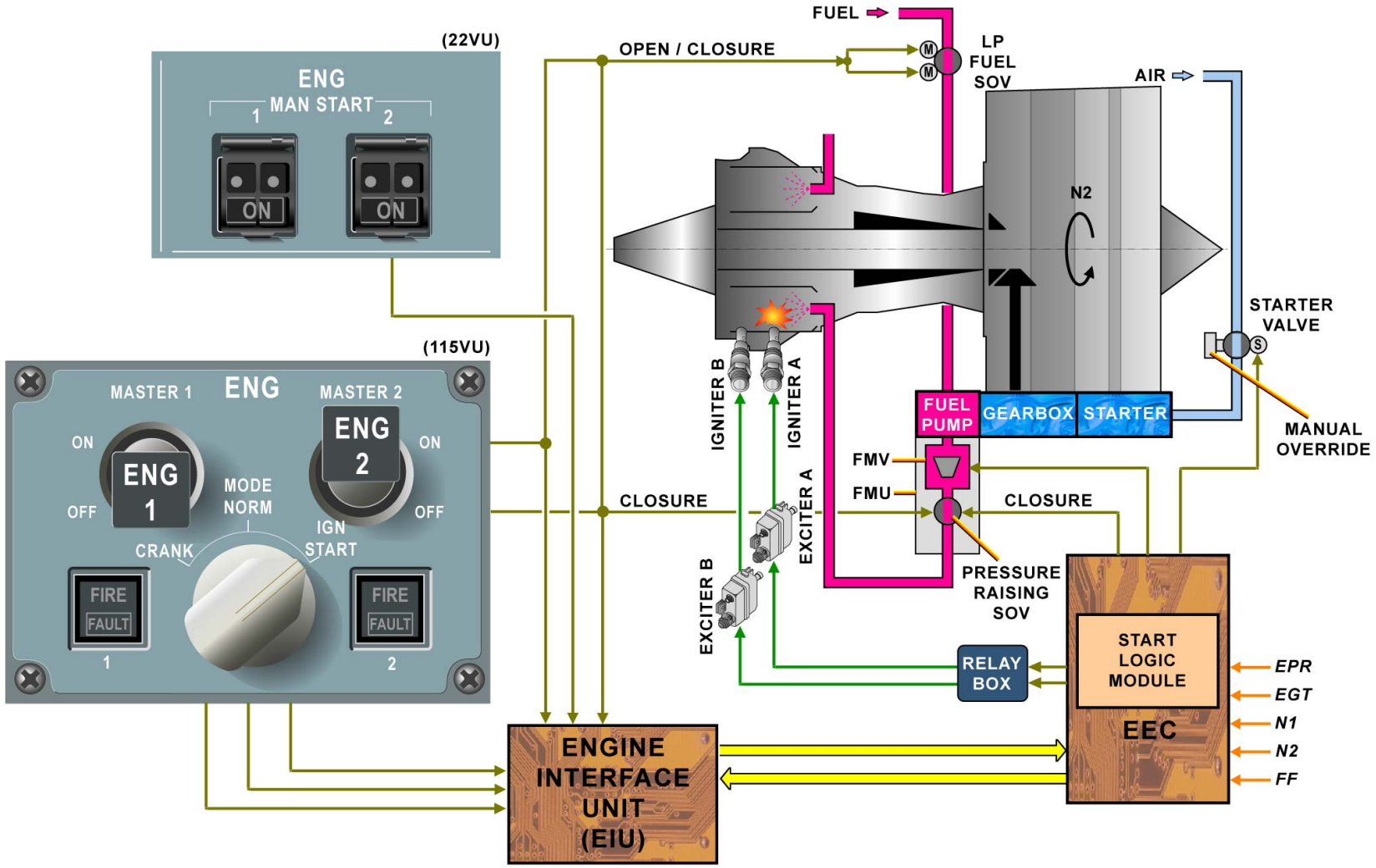
AUTO START - MASTER SWITCH ON

IGNITION & STARTING SYSTEM D/O (3)

AUTO START (continued)

AFTER 30 SECONDS

After 30 seconds and together with the ignition, the EEC opens the Fuel Metering Valve (FMV) and the resulting fuel flow opens the pressure raising and SOV. In case of malfunction, the EEC automatically shuts down the engine and performs a dry motoring sequence.



AUTO START - AFTER 30 SECONDS

IGNITION & STARTING SYSTEM D/O (3)

AUTO START (continued)

N2 AT 43%

When N2 reaches 43%, the EEC closes the starter valve and cuts off the ignition.

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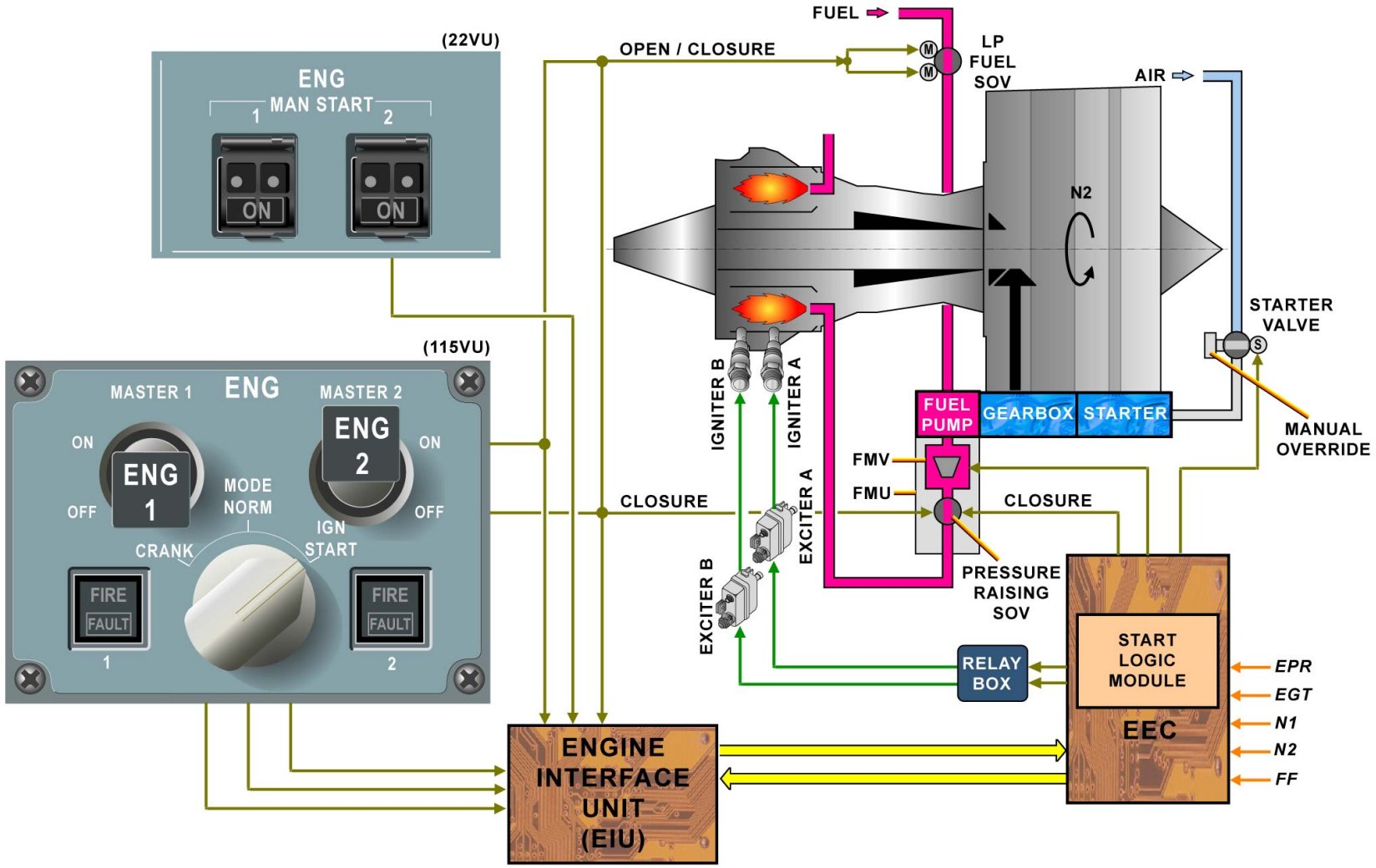

AUTO START - N2 AT 43%

IGNITION & STARTING SYSTEM D/O (3)

AUTO START (continued)

MODE SELECTOR SET TO NORM

Engine 2 is now stabilized at minimum idle.

NOTE: to start the second engine, you leave the MODE selector in the IGN START position, and set the MASTER lever 1 to ON.

After engine start the MODE selector is set to NORMal with the engine running.

WARNING: IF IGN START IS RESELECTED, THE CONTINUOUS RELIGHT FUNCTION IS INITIATED ON THE RUNNING ENGINE(S).

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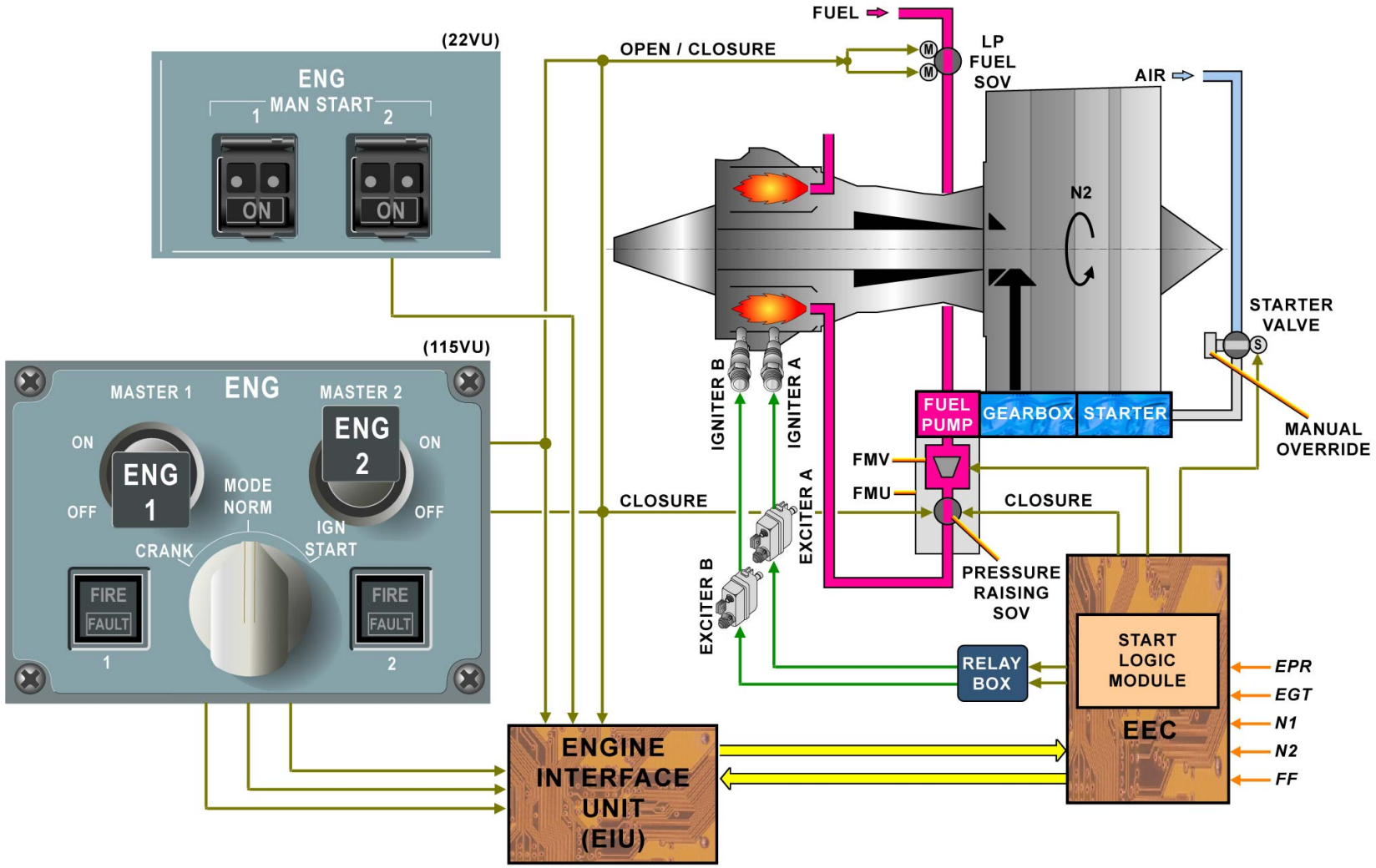


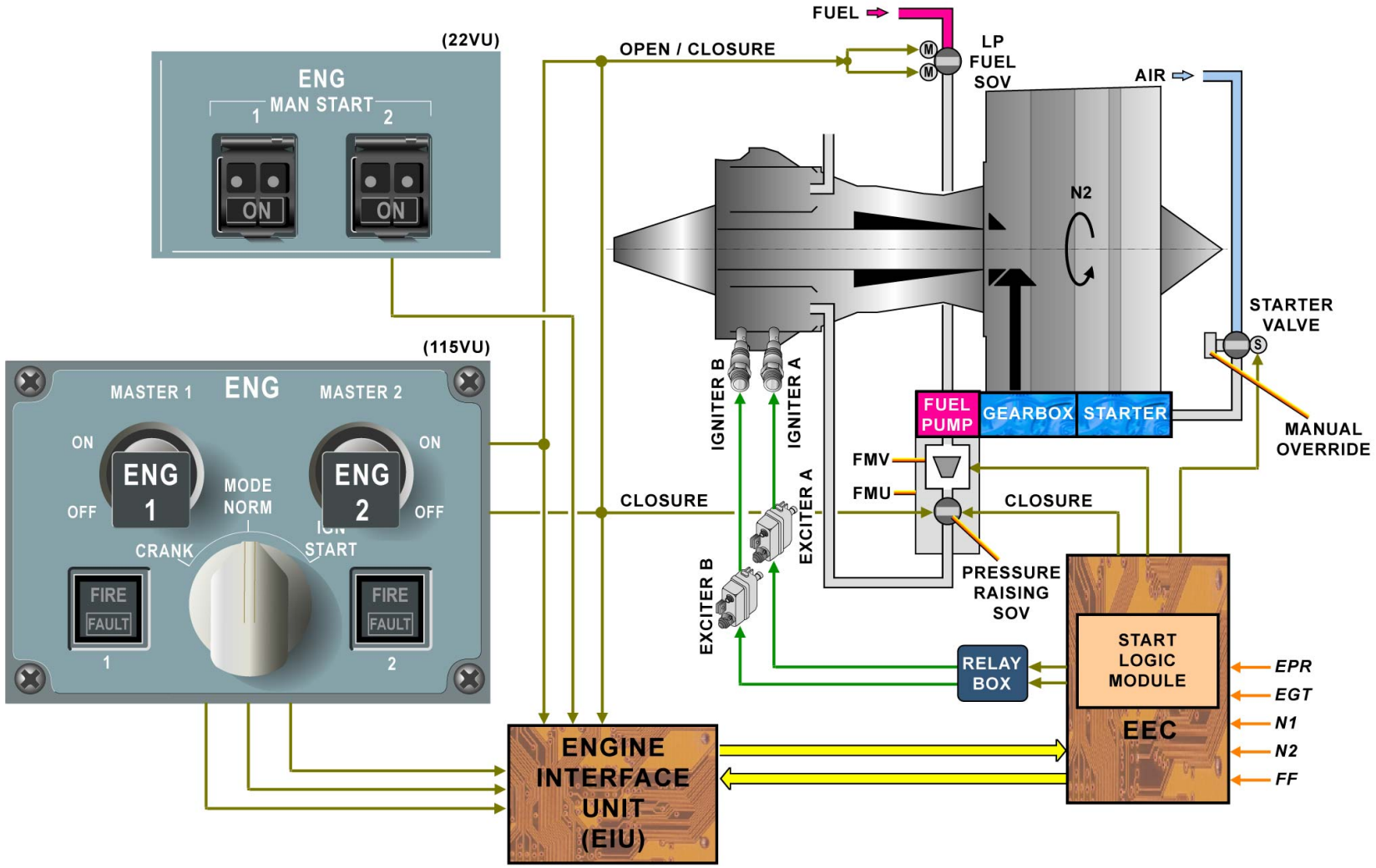
AUTO START - MODE SELECTOR SET TO NORM

IGNITION & STARTING SYSTEM D/O (3)

AUTO START (continued)

MASTER LEVER OFF

At any time, if the MASTER lever is set to OFF, the start sequence or engine operation is stopped because the MASTER lever directly energizes the pressure raising and SOV solenoid. With the MASTER lever to OFF, the LP and pressure raising SOVs close.



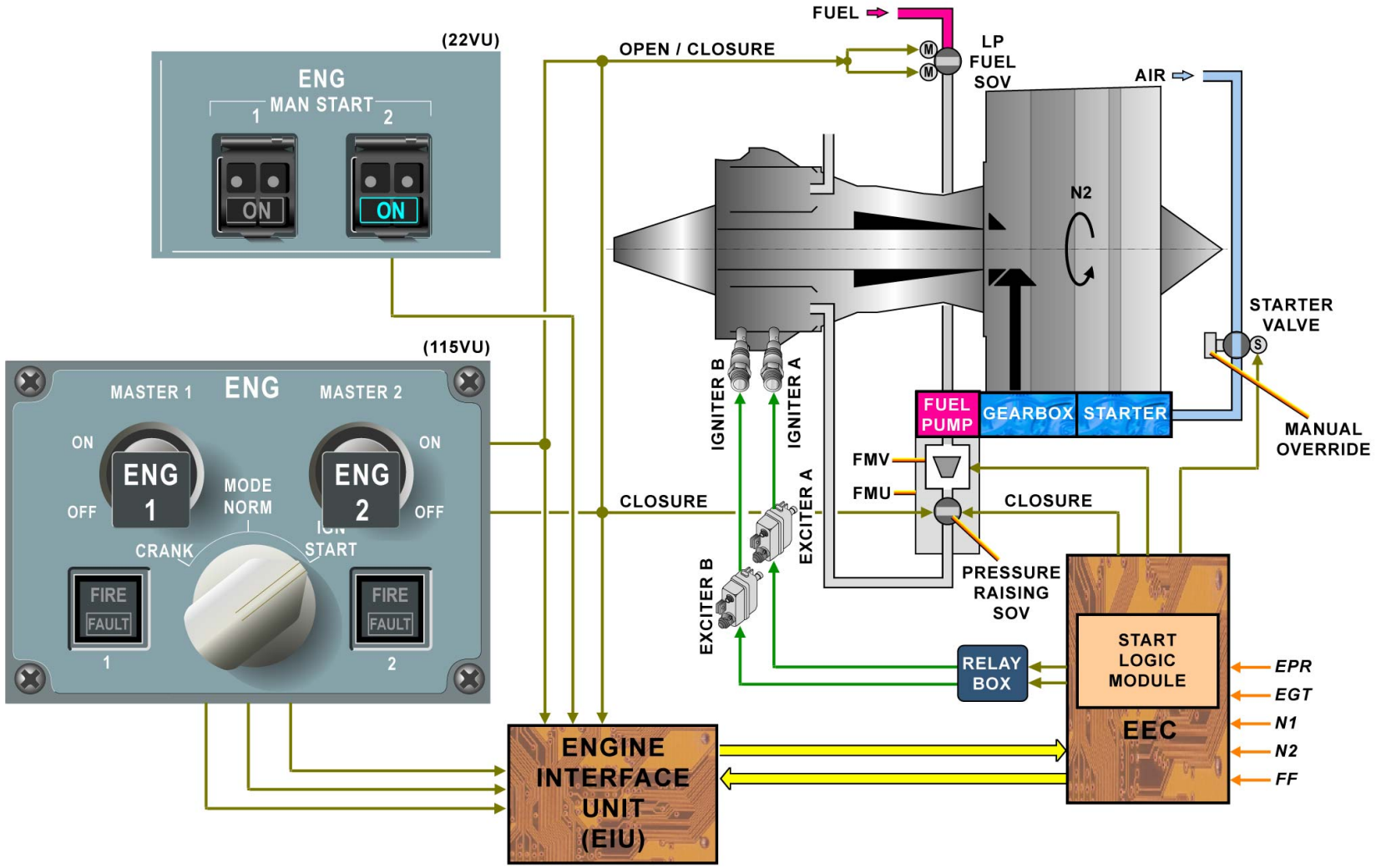
AUTO START - MASTER LEVER OFF

IGNITION & STARTING SYSTEM D/O (3)

MANUAL START

In aircraft configuration, the APU is running and APU bleed air is available. When the MODE selector is set to IGN START, the EEC is armed for the start sequence. Action on the ENG MANual START P/B opens the starter valve, via the EEC. After 30 seconds dry crank, set the ENG/MASTER control switch to ON.

UGB13131 - U7ST0M0 - UM74D11AE000003



MANUAL START

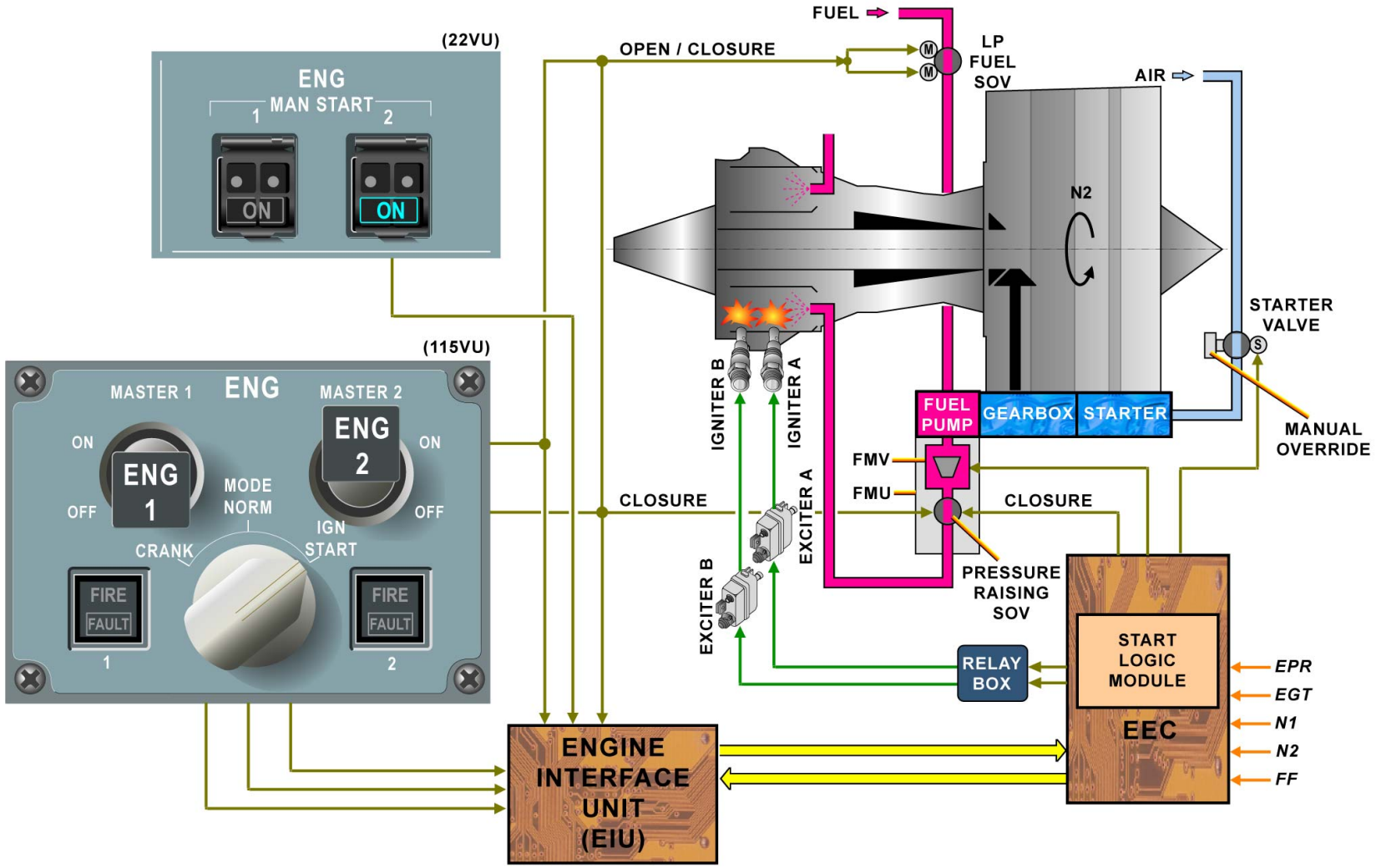
IGNITION & STARTING SYSTEM D/O (3)

MANUAL START (continued)

AFTER 30 SECONDS

As soon as the MASTER lever is in the ON position, both ignition systems are energized, LP and pressure raising SOVs open and the fuel flow increases. A dual ignition and a fuel flow start. The MAN START P/B stays latched and is normally left alone during the start sequence.

UGB13131 - U7ST0M0 - UM74D11AE000003



MANUAL START - AFTER 30 SECONDS

IGNITION & STARTING SYSTEM D/O (3)

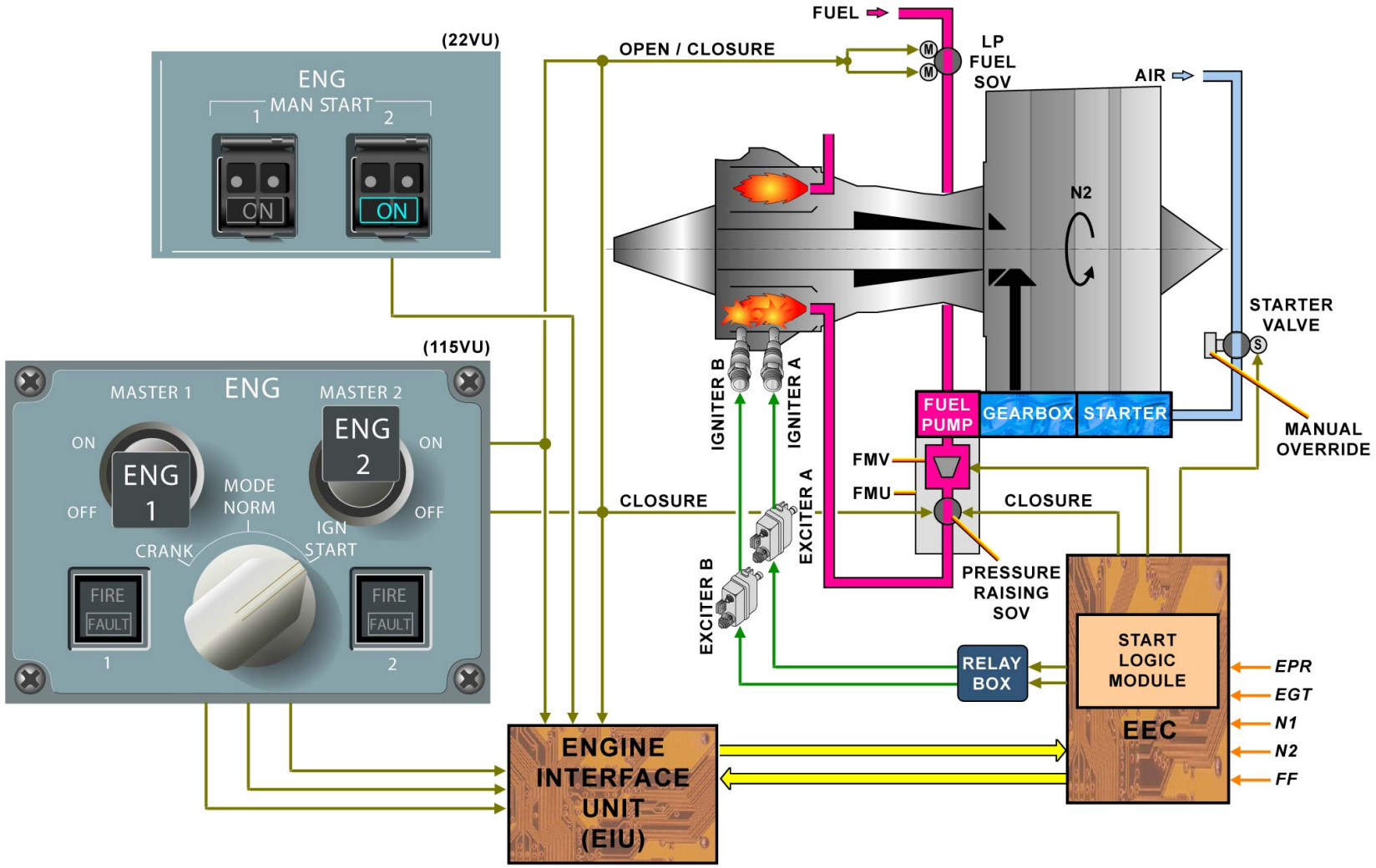
MANUAL START (continued)

EGT INCREASING

Action on the MAN START P/B has no effect on the start sequence as long as the MASTER lever is set in the ON position. The MAN START P/B is normally released at the end when the engine parameters are stabilized. In case of malfunction, set the MASTER lever in the OFF position to abort the start. Start for up to 2 minutes maximum.

NOTE: there is no automatic shutdown function in manual start.

UGB13131 - U7ST0M0 - UM74D11AE000003



MANUAL START - EGT INCREASING

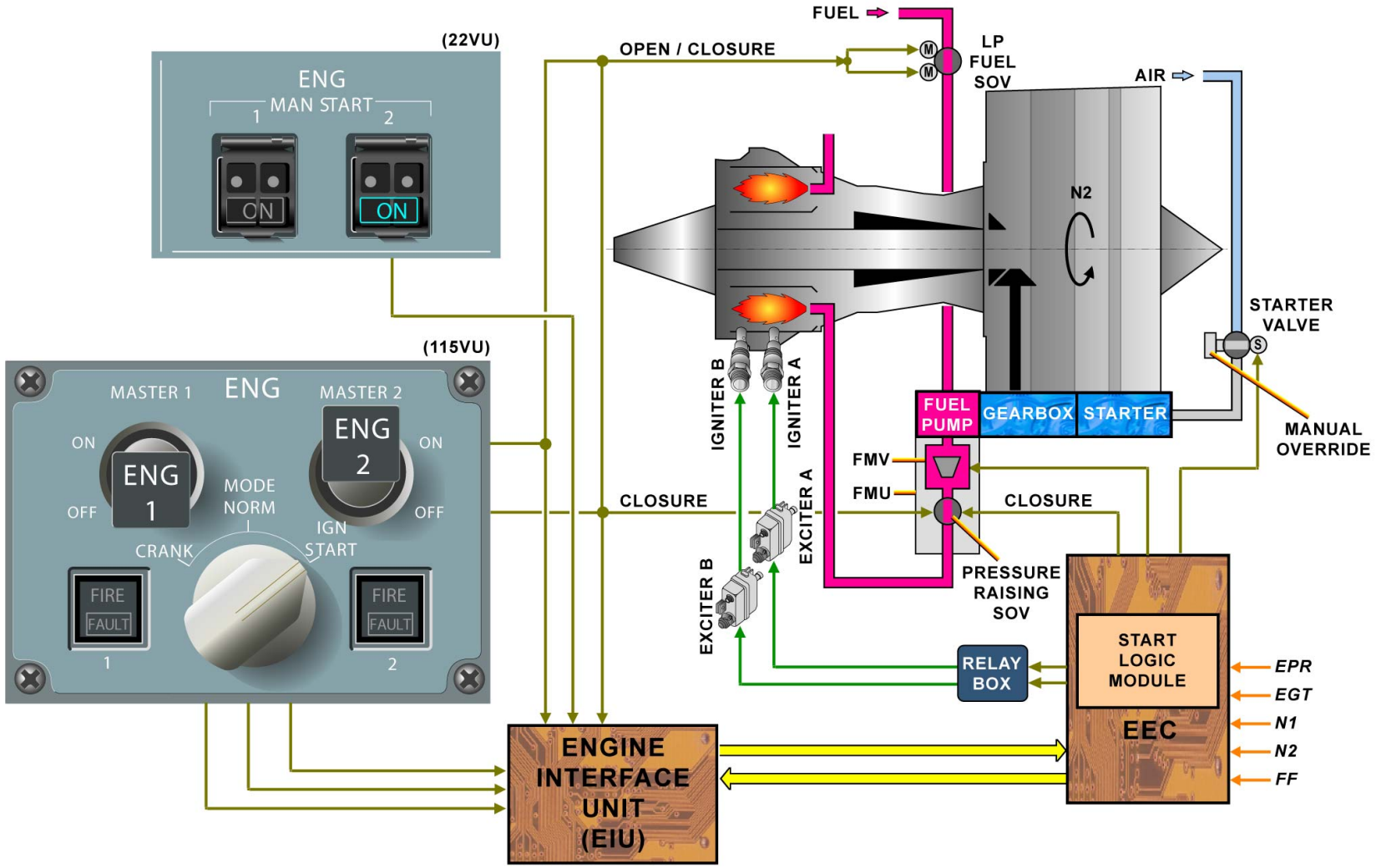
IGNITION & STARTING SYSTEM D/O (3)

MANUAL START (continued)

N2 AT 43%

When N2 reaches 43%, the EEC closes the starter valve and cuts off the ignition.

UGB13131 - U7ST0M0 - UM74D11AE000003



MANUAL START - N2 AT 43%

IGNITION & STARTING SYSTEM D/O (3)

MANUAL START (continued)

MODE SELECTOR SET TO NORM

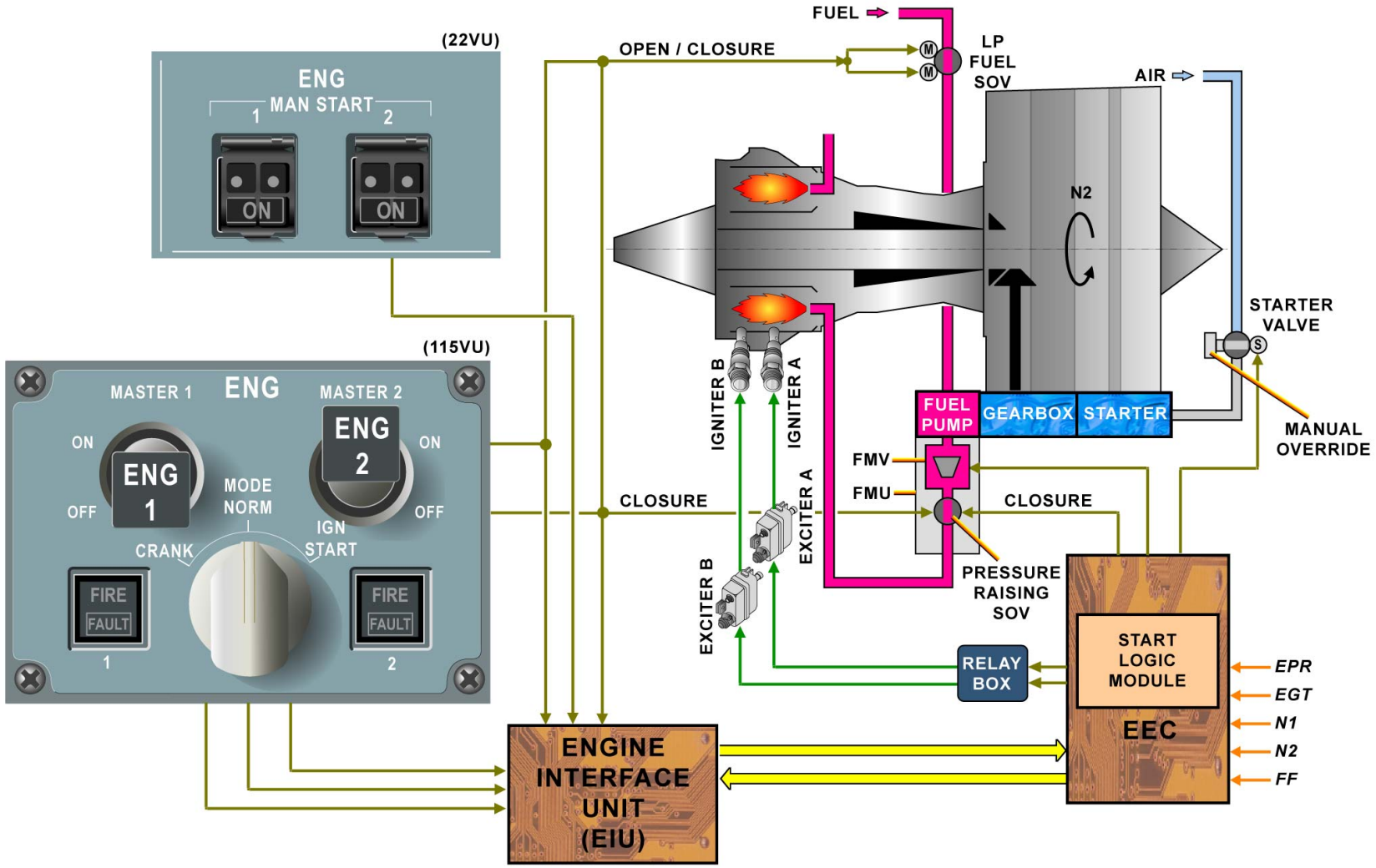
Engine 2 is now stabilized at minimum idle.

NOTE: to start the second engine, you leave the MODE selector in the IGN START position, and set the MAN START P/B to ON, and after 30 seconds dry crank set the MASTER lever to ON.

After engine start the MODE selector is set to NORM with the engine running.

WARNING: IF IGN START IS RESELECTED, THE CONTINUOUS RELIGHT FUNCTION IS INITIATED ON THE RUNNING ENGINE(S).

UGB13131 - U7ST0M0 - UM74D11AE000003



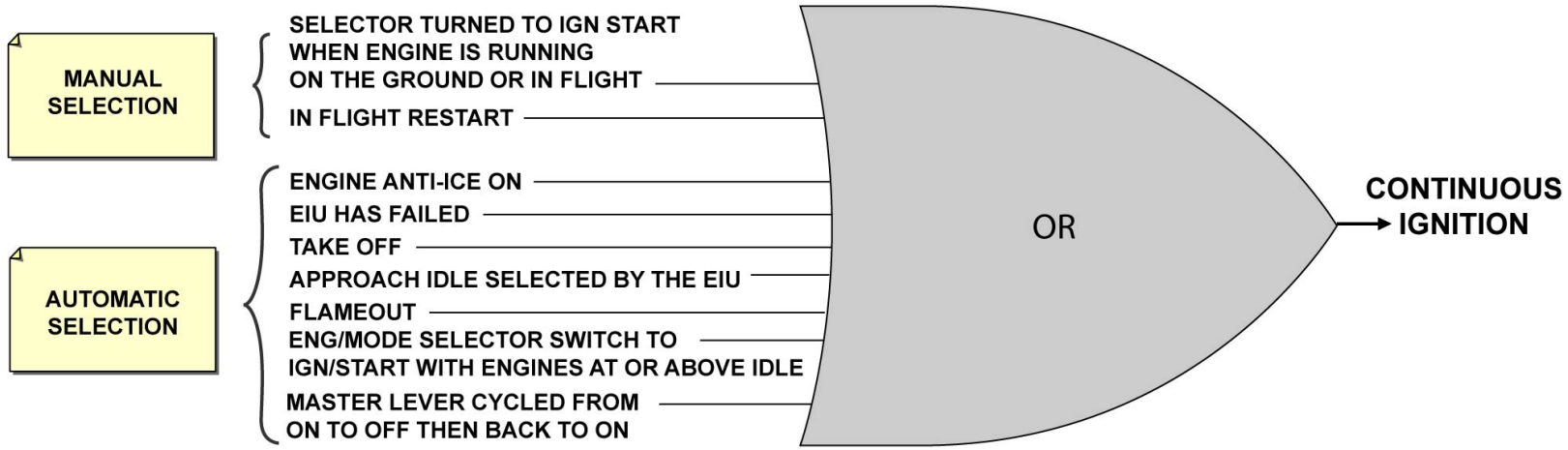
MANUAL START - MODE SELECTOR SET TO NORM

IGNITION & STARTING SYSTEM D/O (3)

CONTINUOUS RELIGHT

In aircraft configuration:
- the APU is running and APU bleed air is available,
- engine 2 is running.

The continuous ignition is manually selected or automatically controlled by the EEC according to the following logic.


MANUAL SELECTION
SELECTOR TURNED TO IGN START WHEN ENGINE IS RUNNING ON THE GROUND OR IN FLIGHT
IN FLIGHT RESTART
AUTOMATIC SELECTION
ENGINE ANTI-ICE ON
EIU HAS FAILED
TAKE OFF
APPROACH IDLE SELECTED BY THE EIU
FLAMEOUT
ENG/MODE SELECTOR SWITCH TO IGN/START WITH ENGINES AT OR ABOVE IDLE
MASTER LEVER CYCLED FROM ON TO OFF THEN BACK TO ON
OR
CONTINUOUS IGNITION

CONTINUOUS RELIGHT

UGB13131 - U7ST0M0 - UM74D11AE000003

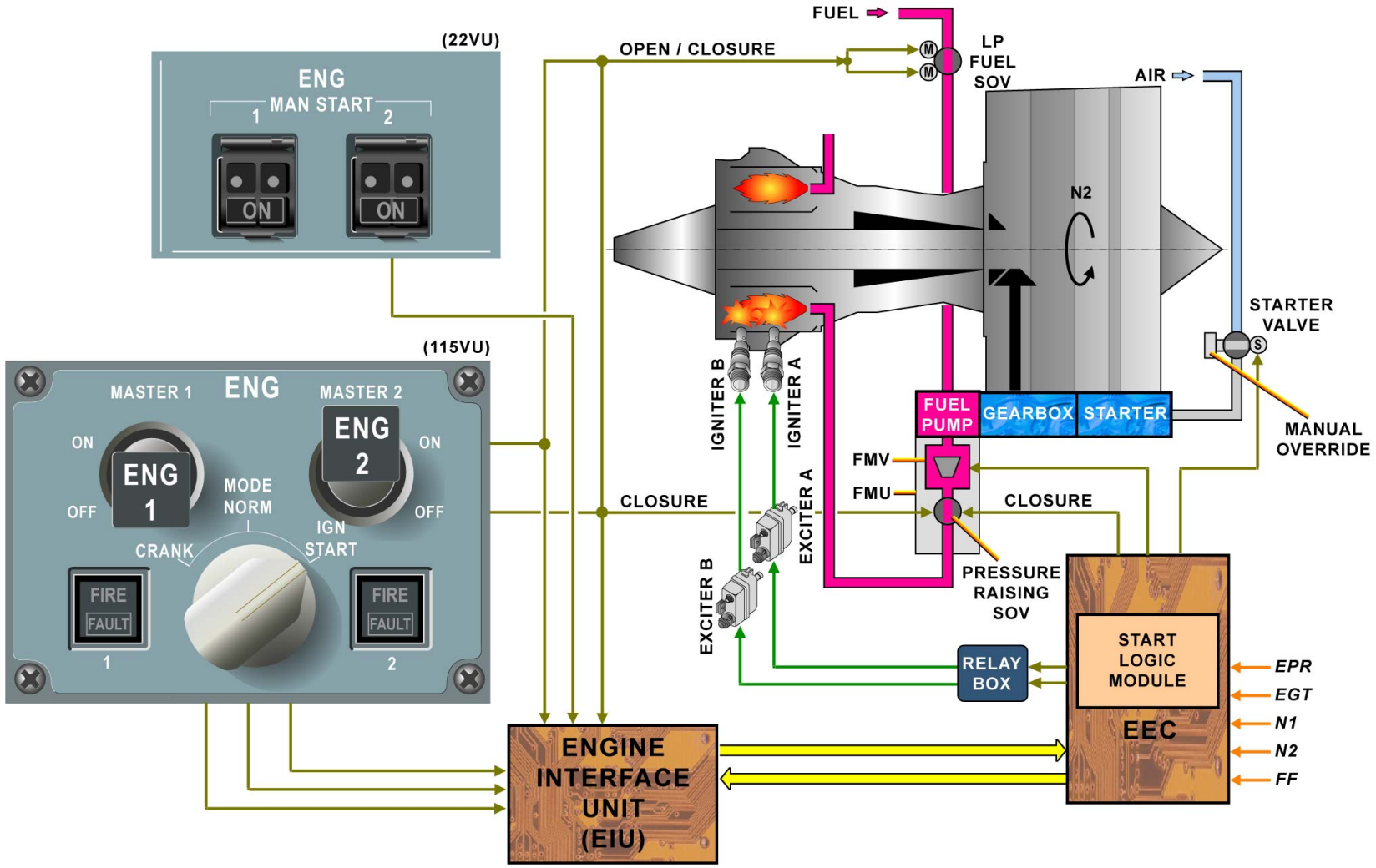
IGNITION & STARTING SYSTEM D/O (3)

CONTINUOUS RELIGHT (continued)

IGN START SELECTION

IF IGNition START is reselected with an engine running, the corresponding EEC supplies the 2 igniters together, to provide continuous ignition.

UGB13131 - U7ST0M0 - UM74D11AE000003



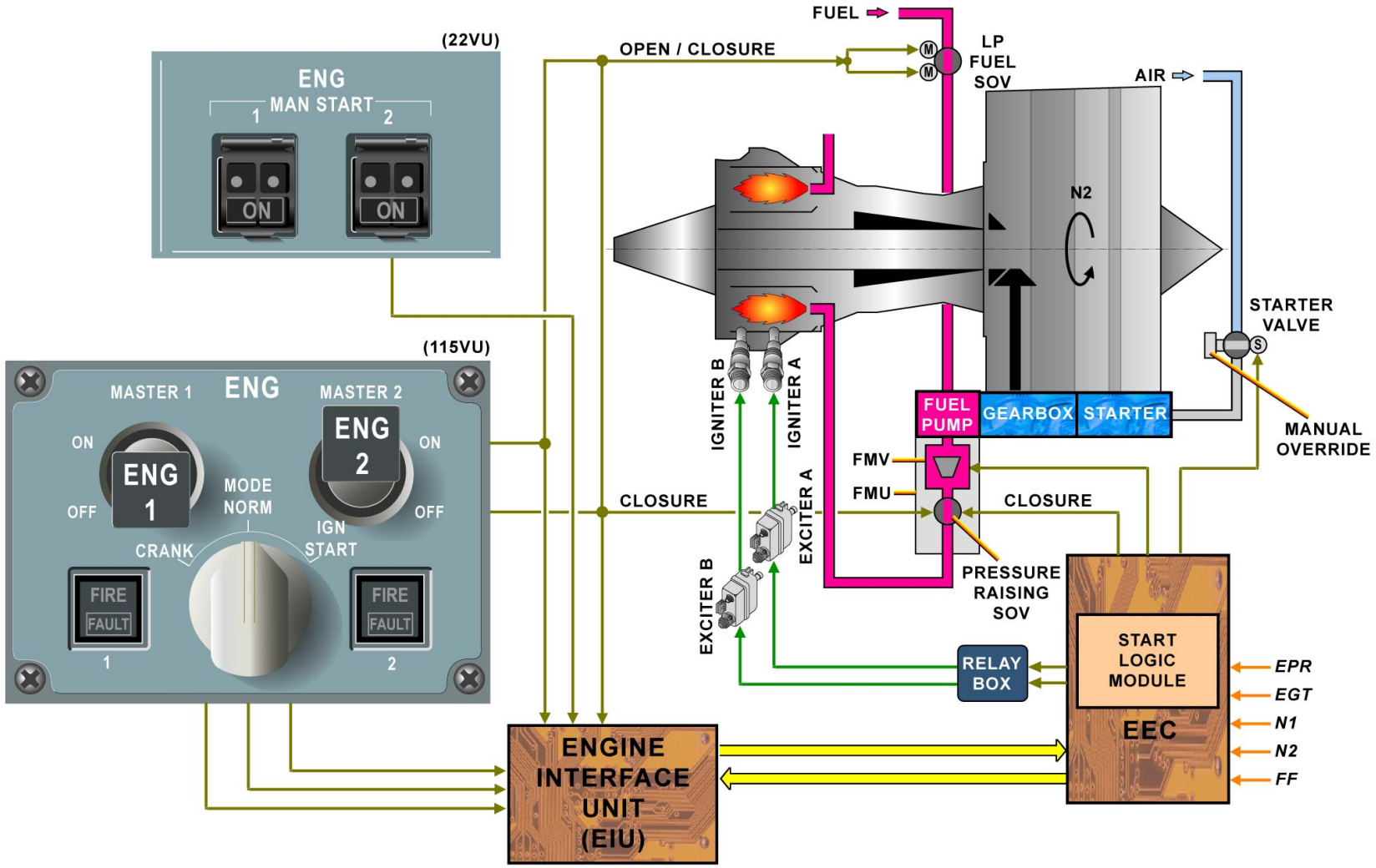
CONTINUOUS RELIGHT - IGN START SELECTION

IGNITION & STARTING SYSTEM D/O (3)

CONTINUOUS RELIGHT (continued)

NORM SELECTION

When NORM is restored, the continuous relight is cut off.



CONTINUOUS RELIGHT - NORM SELECTION

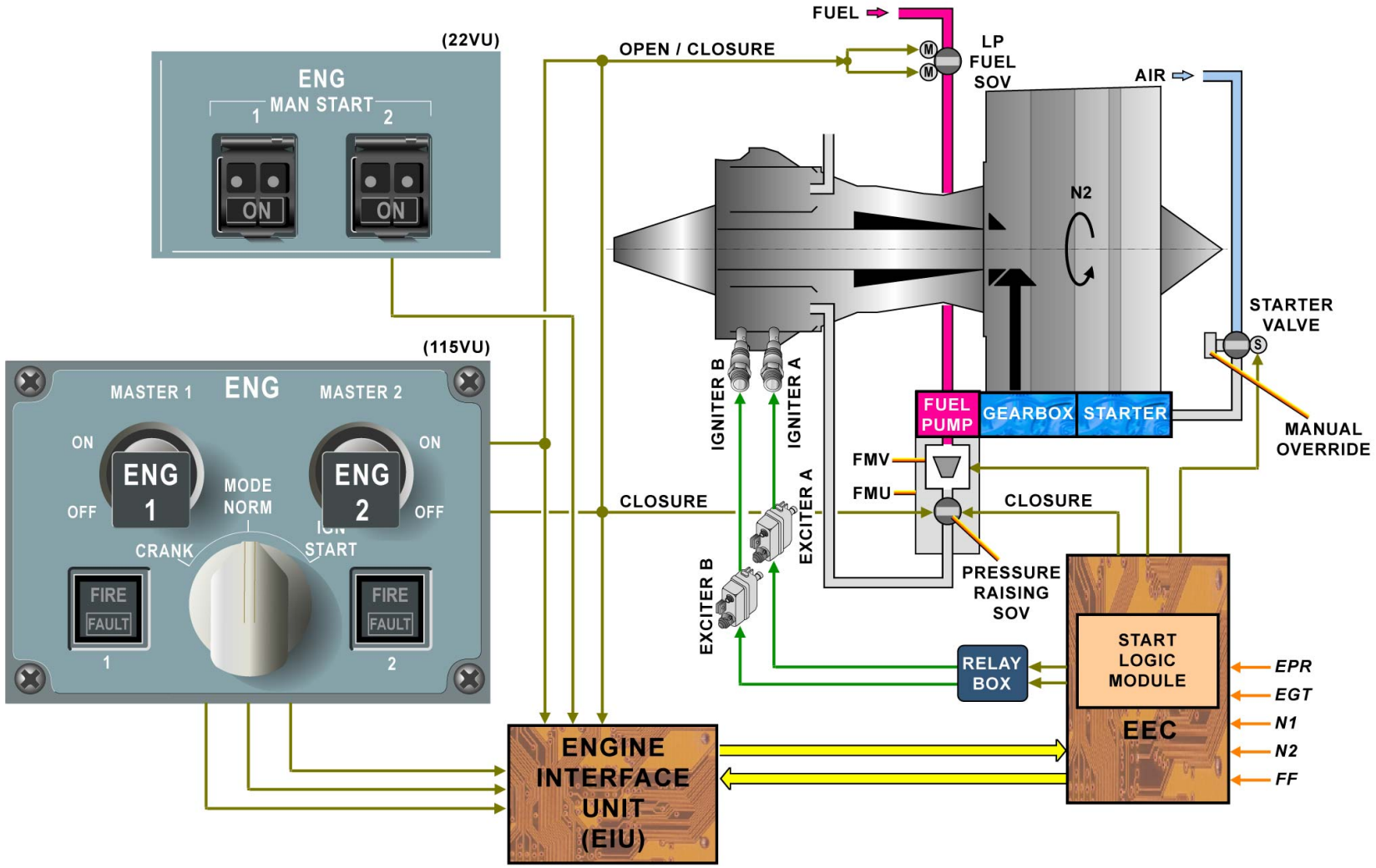
IGNITION & STARTING SYSTEM D/O (3)

CONTINUOUS RELIGHT (continued)

MASTER LEVER OFF

When the MASTER lever is set to OFF, the LP and pressure raising SOVs close and the EEC functions are reset. Engine 2 is shut down.

UGB13131 - U7ST0M0 - UM74D11AE000003



CONTINUOUS RELIGHT - MASTER LEVER OFF

IGNITION & STARTING SYSTEM D/O (3)

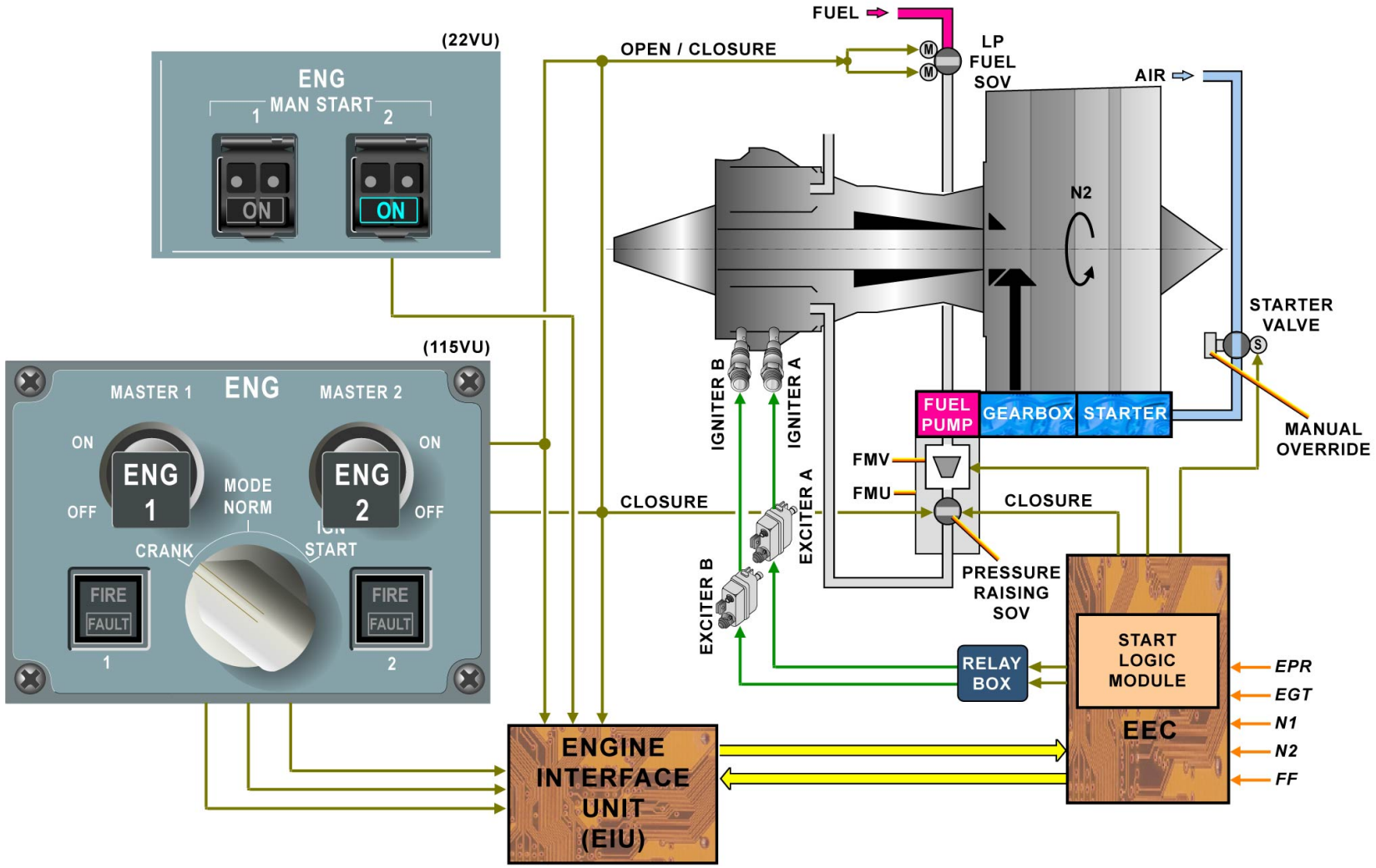
ENGINE DRY CRANK

In aircraft configuration:
- the APU is running and APU bleed air is available,
- both engines are shut down.

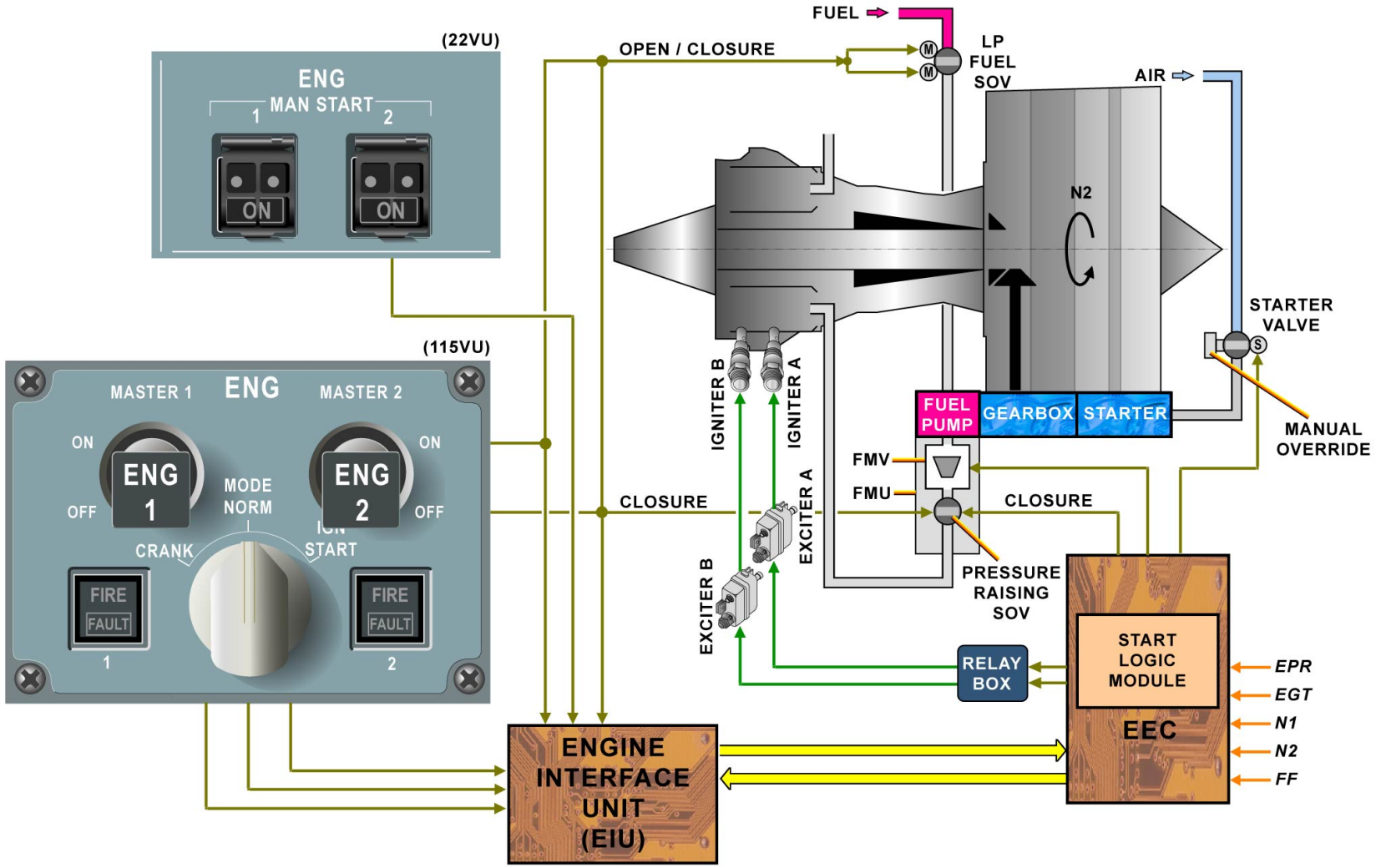
When CRANK is selected on the ground, the ignition is inhibited. Action on the ENG MAN START P/B provides opening of the starter valve via the EEC. During the crank sequence, the starter limitations should be observed. If the starter operation time is exceeded, a warning message is displayed on the ECAM, but there is no automatic abort.
The starter limitations when performing a dry crank are:
- a maximum of 3 consecutive cycles; 2 minutes on, 15 seconds off up 2 times and one minute on, then 30 minutes off for cooling,
- or 4 continuous minutes on, then 30 minutes off for cooling.

When the MAN START P/B is released out, the starter valve closes and the engine shuts down. To complete the crank sequence the MODE selector is set in the NORM position.

UGB13131 - U7ST0M0 - UM74D11AE000003



ENGINE DRY CRANK



ENGINE DRY CRANK

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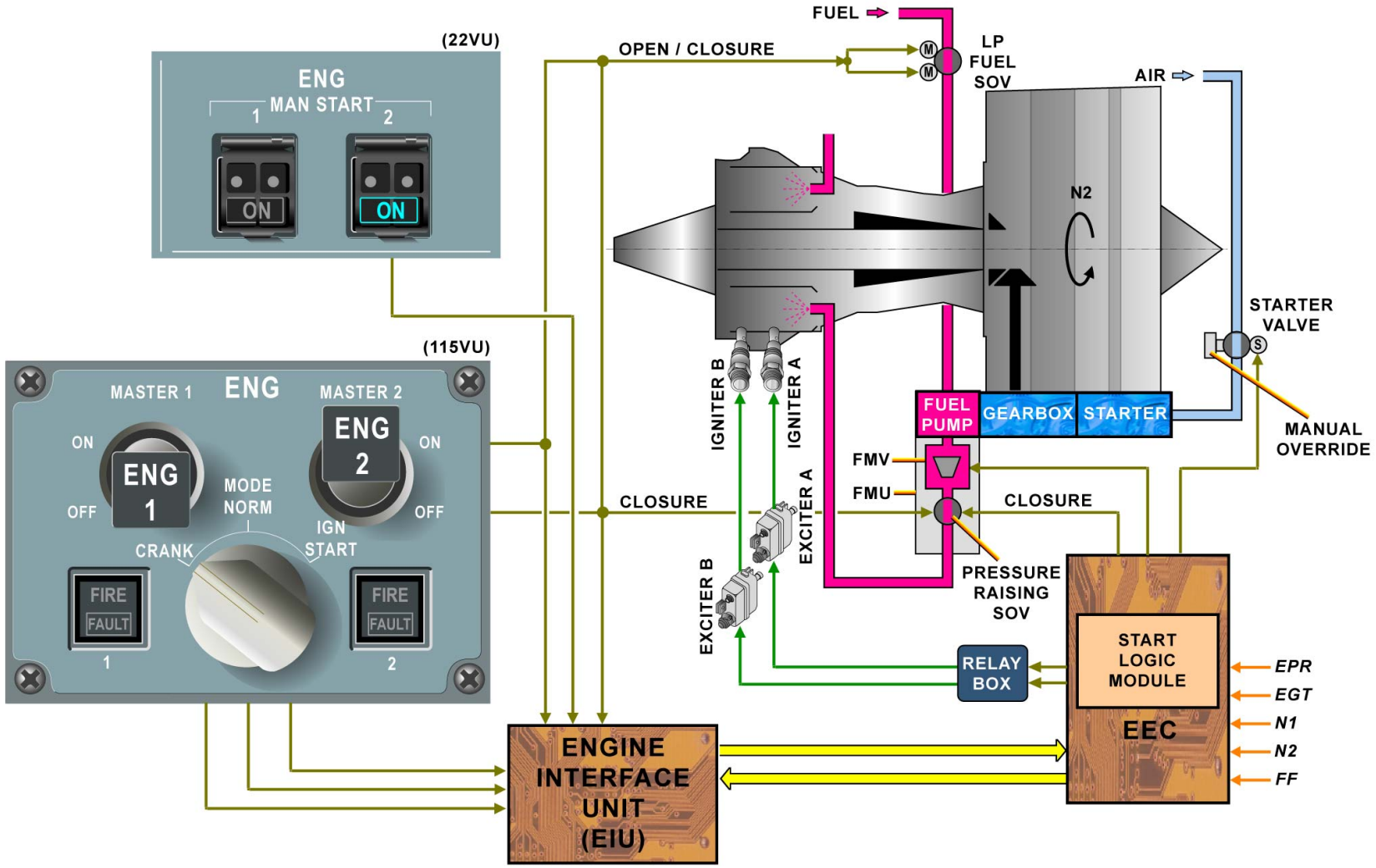
IGNITION & STARTING SYSTEM D/O (3)

ENGINE DRY CRANK (continued)

ENGINE WET CRANK-LEVER ON

To perform a wet crank, allow N2 to increase to 20% RPM before setting the MASTER lever to ON. When the MASTER lever is set in the ON position, the LP and pressure raising SOVs open.

UGB13131 - U7ST0M0 - UM74D11AE000003



ENGINE DRY CRANK - ENGINE WET CRANK-LEVER ON

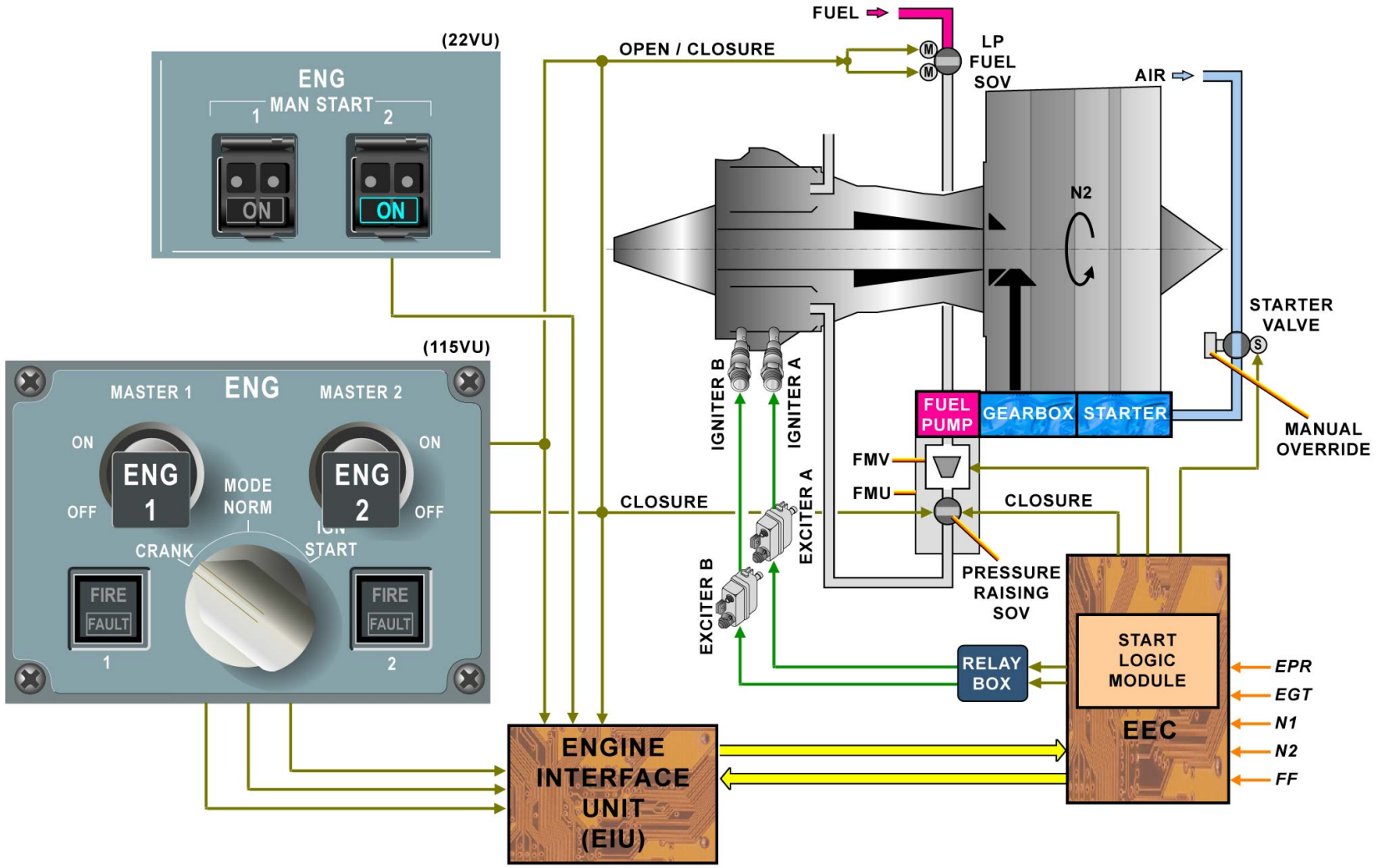
IGNITION & STARTING SYSTEM D/O (3)

ENGINE DRY CRANK (continued)

ENGINE WET CRANK-CRANK

After wet cranking, the MASTER lever must be set to OFF. The EEC closes the starter valve and reopens it automatically when the N2 is below 10% and dry cranking follows to eliminate fuel vapors from the engine. Continue to dry crank for a minimum of 60 seconds.

UGB13131 - U7ST0M0 - UM74D11AE000003



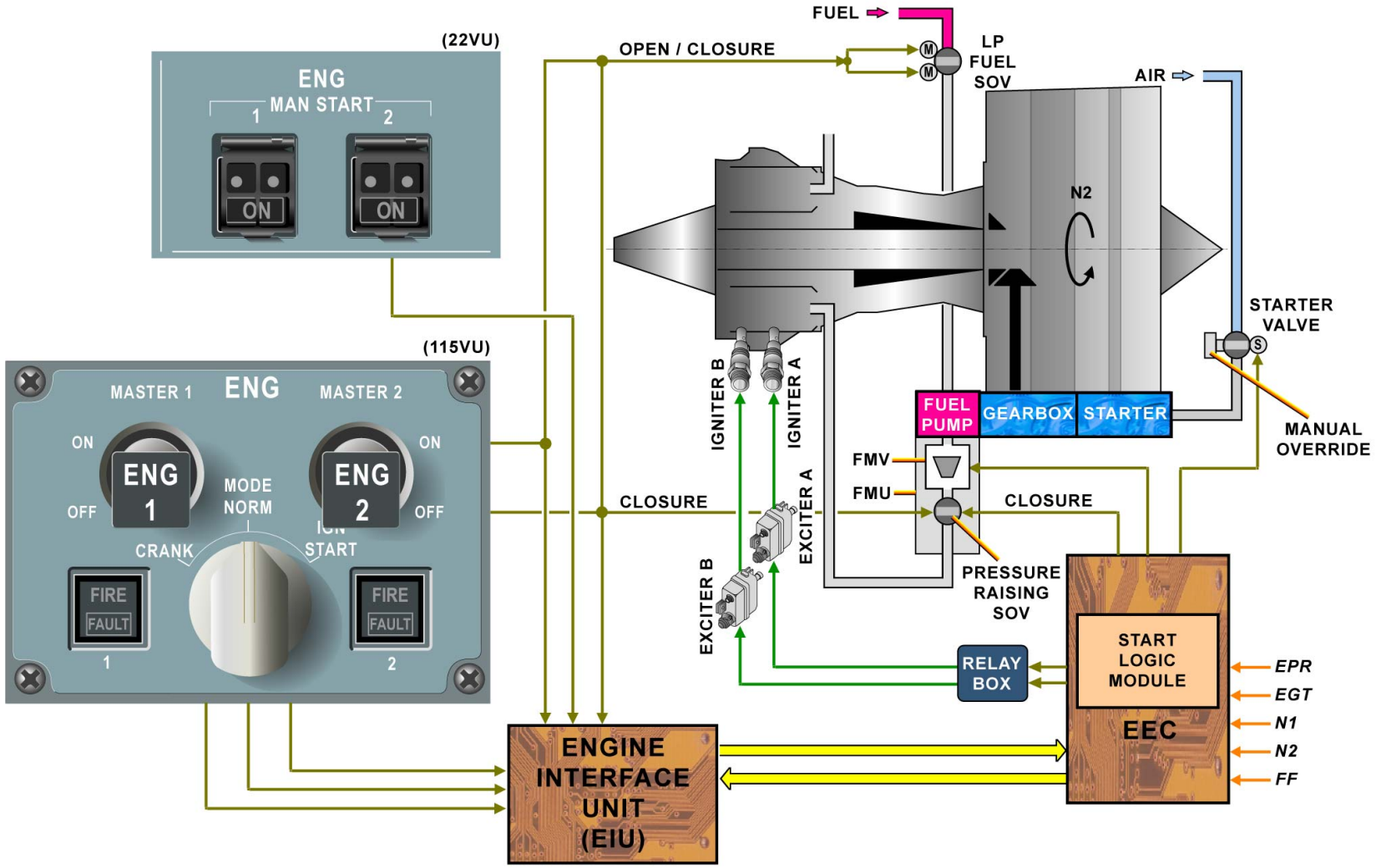
ENGINE DRY CRANK - ENGINE WET CRANK-CRANK

IGNITION & STARTING SYSTEM D/O (3)

ENGINE DRY CRANK (continued)

MODE SELECTOR SET TO NORM

When the MAN START P/B is released out, the starter valve closes and the engine shuts down. To complete the crank sequence the MODE selector is set in the NORM position.



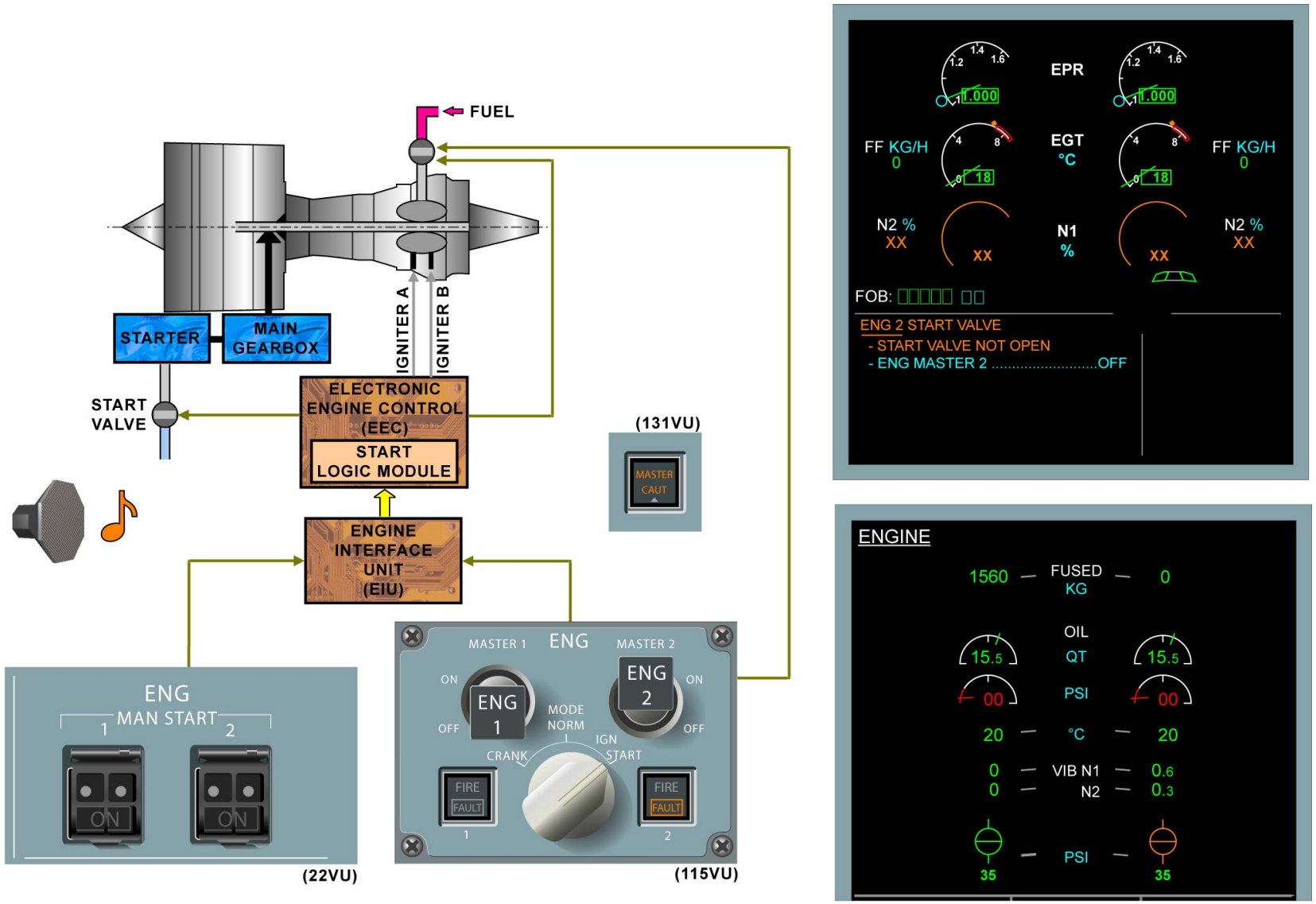
ENGINE DRY CRANK - MODE SELECTOR SET TO NORM

START FAILURES (ME) (3)

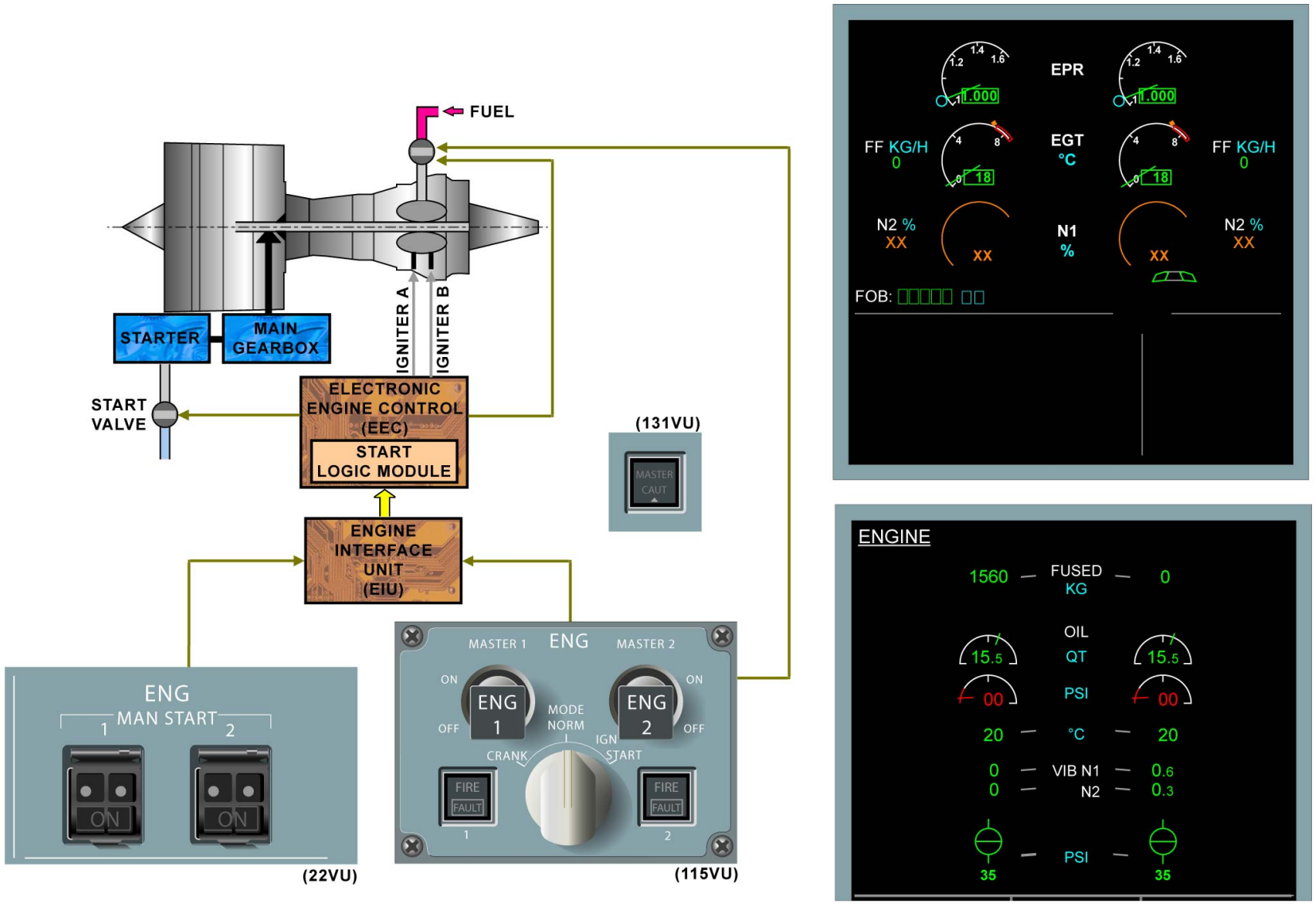
START VALVE (NOT OPEN)

If the start valve does not open, an aural warning operates. The MASTER CAUTion and the ENGine FAULT lights come on. An ECAM message comes into view. The Full Authority Digital Engine Control (FADEC) aborts the start sequence.
Another start with a manual operation of the start valve is then done. For this, tell the ground crew to prepare for a start valve manual operation.
Make sure that if the opposite engine is in operation, the X BLEED P/B is ON, or if the APU is available, the APU BLEED P/B is ON.
Do an automatic start, set the MODE selector to IGNition.
When the MASTER lever is set to ON, tell the ground crew to open the start valve.
The start valve is opened.
When N2 is at 43%, tell the ground crew to close the start valve.
The start valve is closed, the engine is now in operation, continue with the normal procedure.

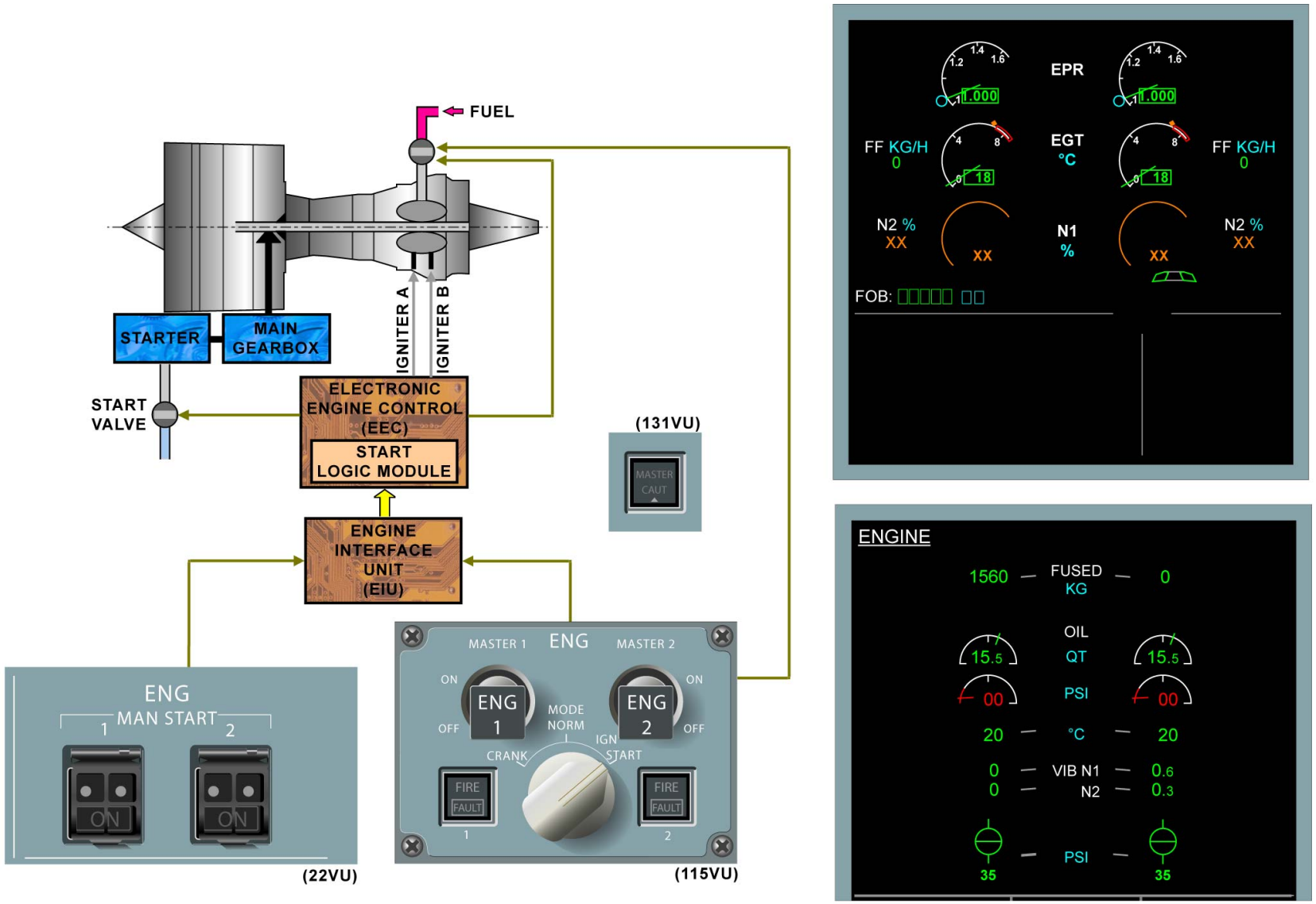
UGB13131 - U7ST0M0 - UM74D2IAE000003



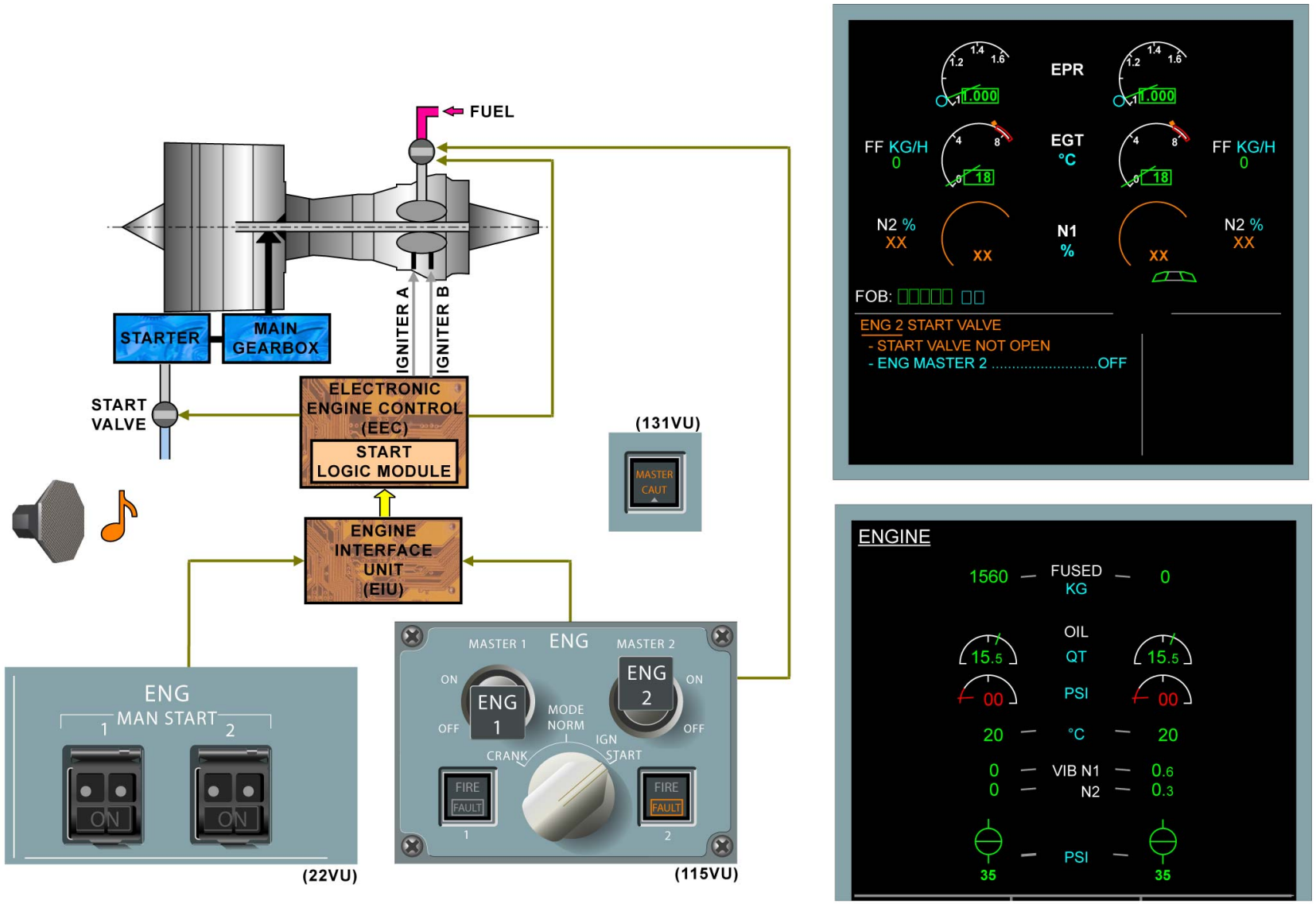
START VALVE (NOT OPEN)



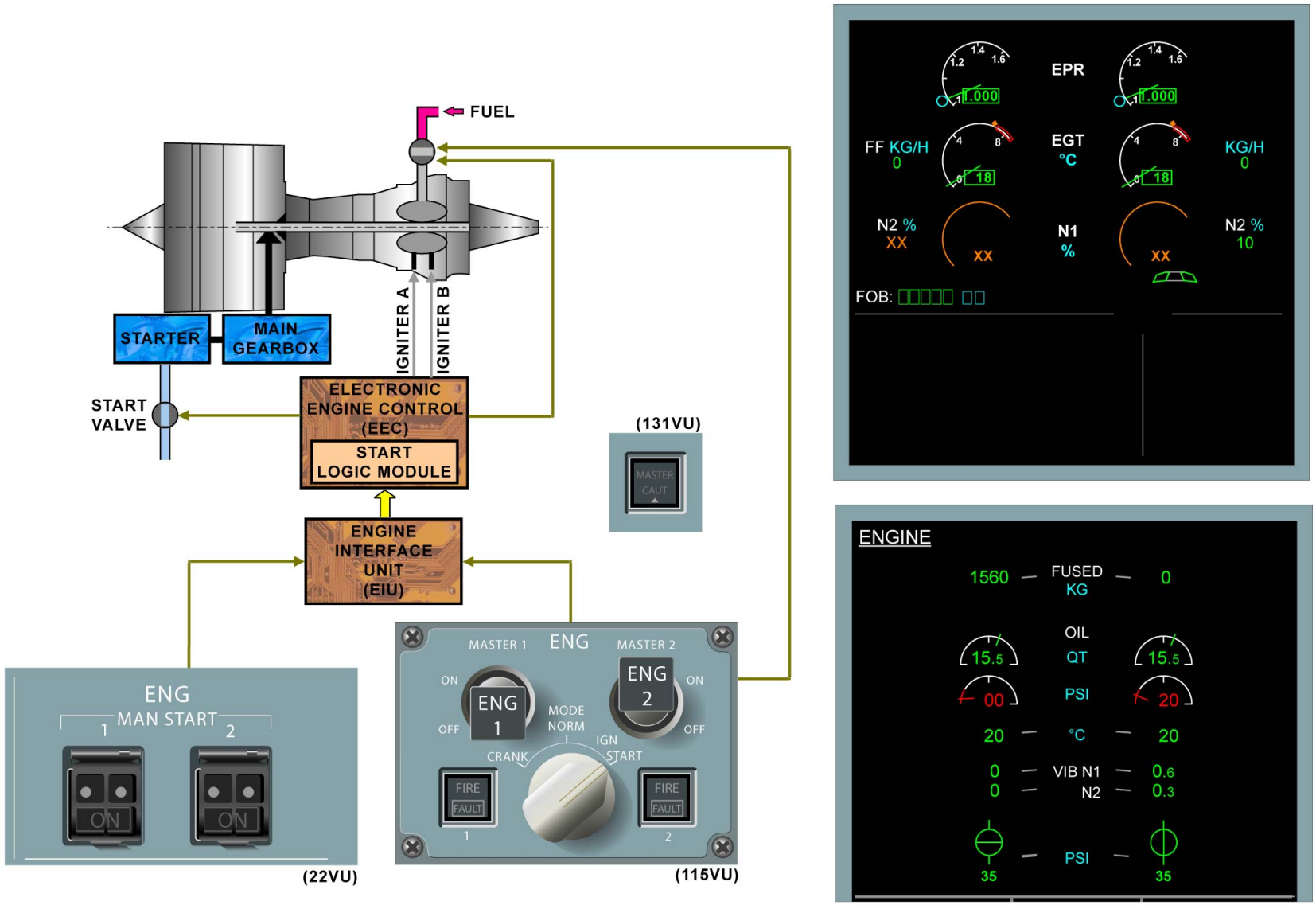
START VALVE (NOT OPEN)



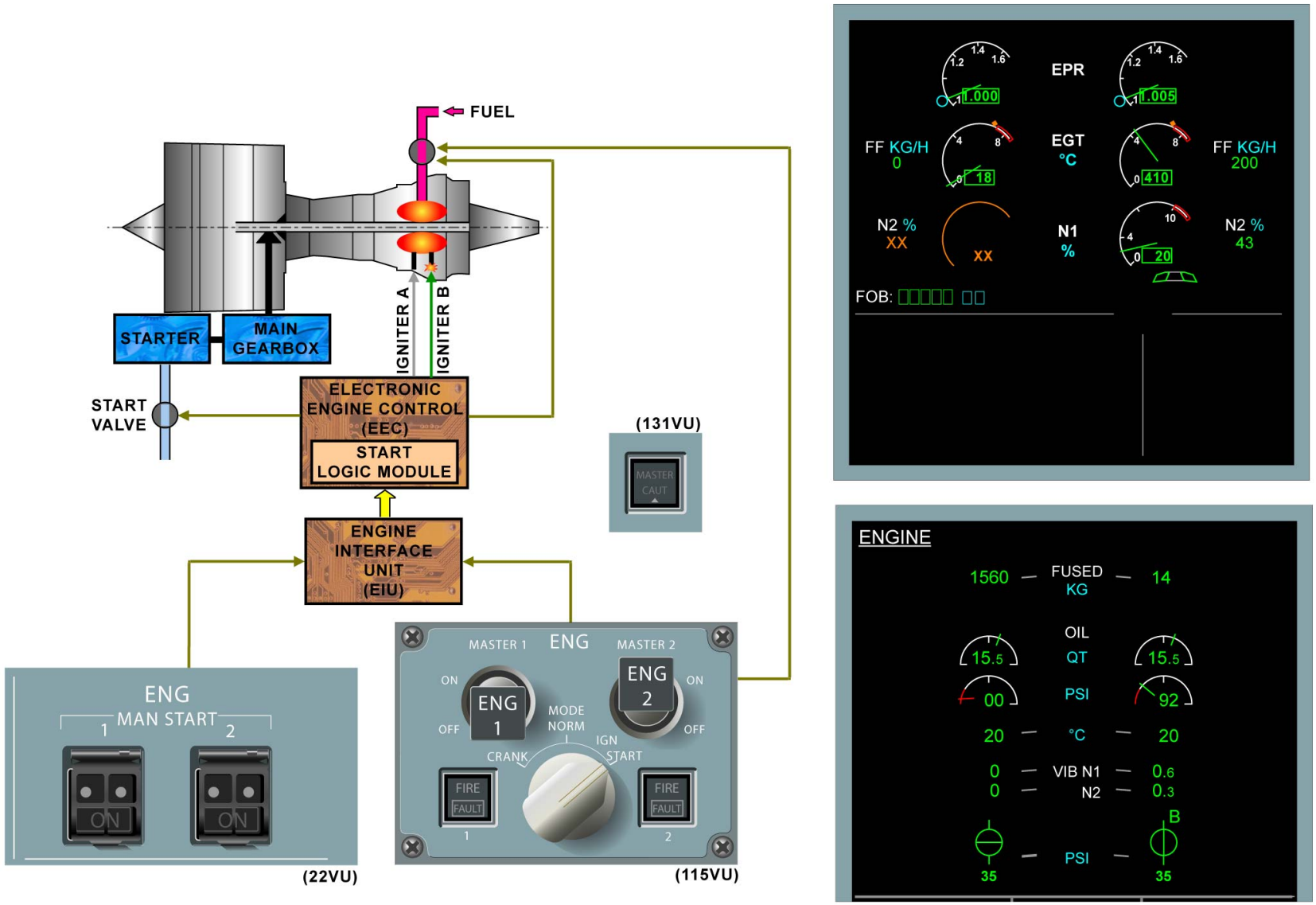
START VALVE (NOT OPEN)



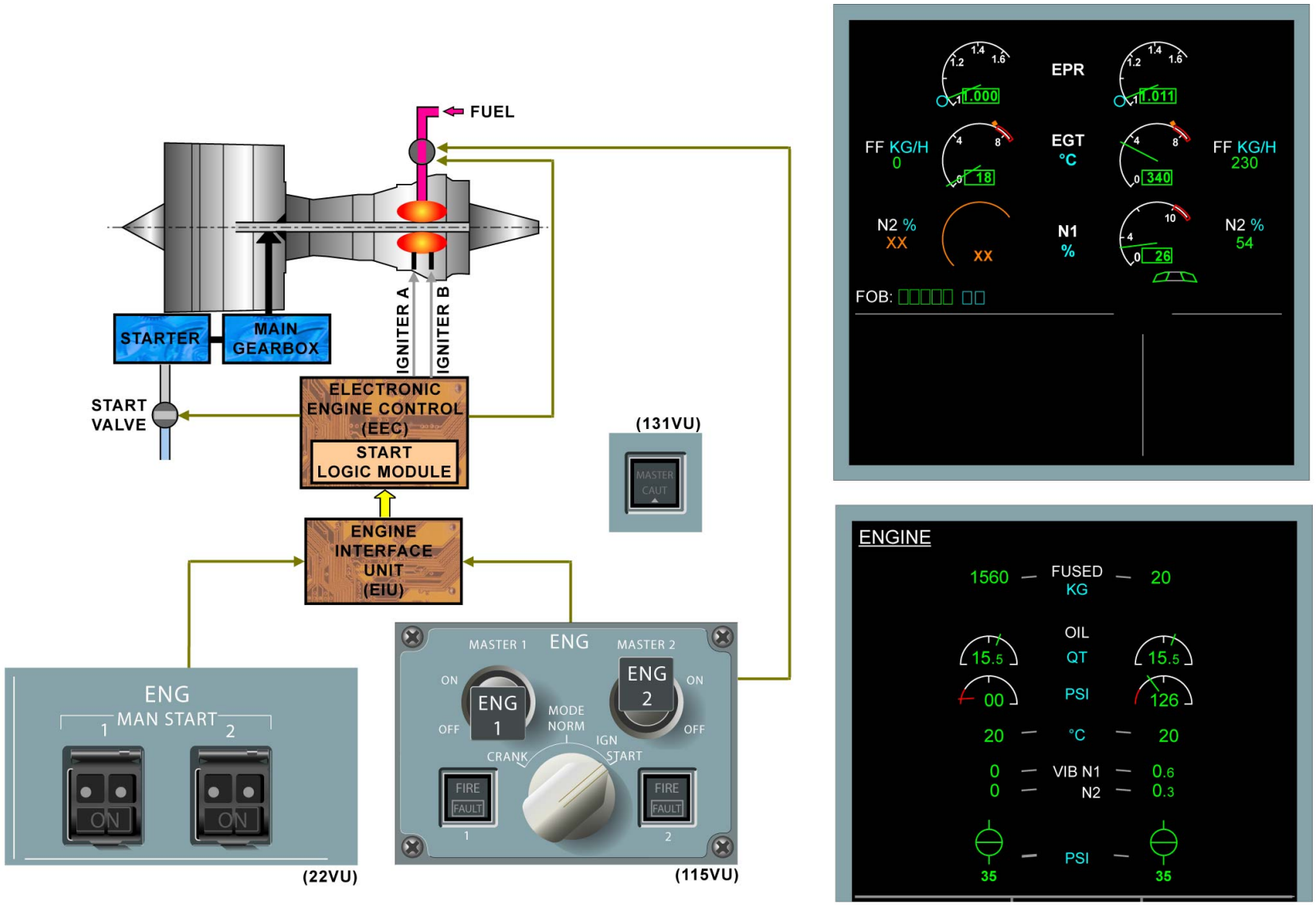
START VALVE (NOT OPEN)



START VALVE (NOT OPEN)



START VALVE (NOT OPEN)



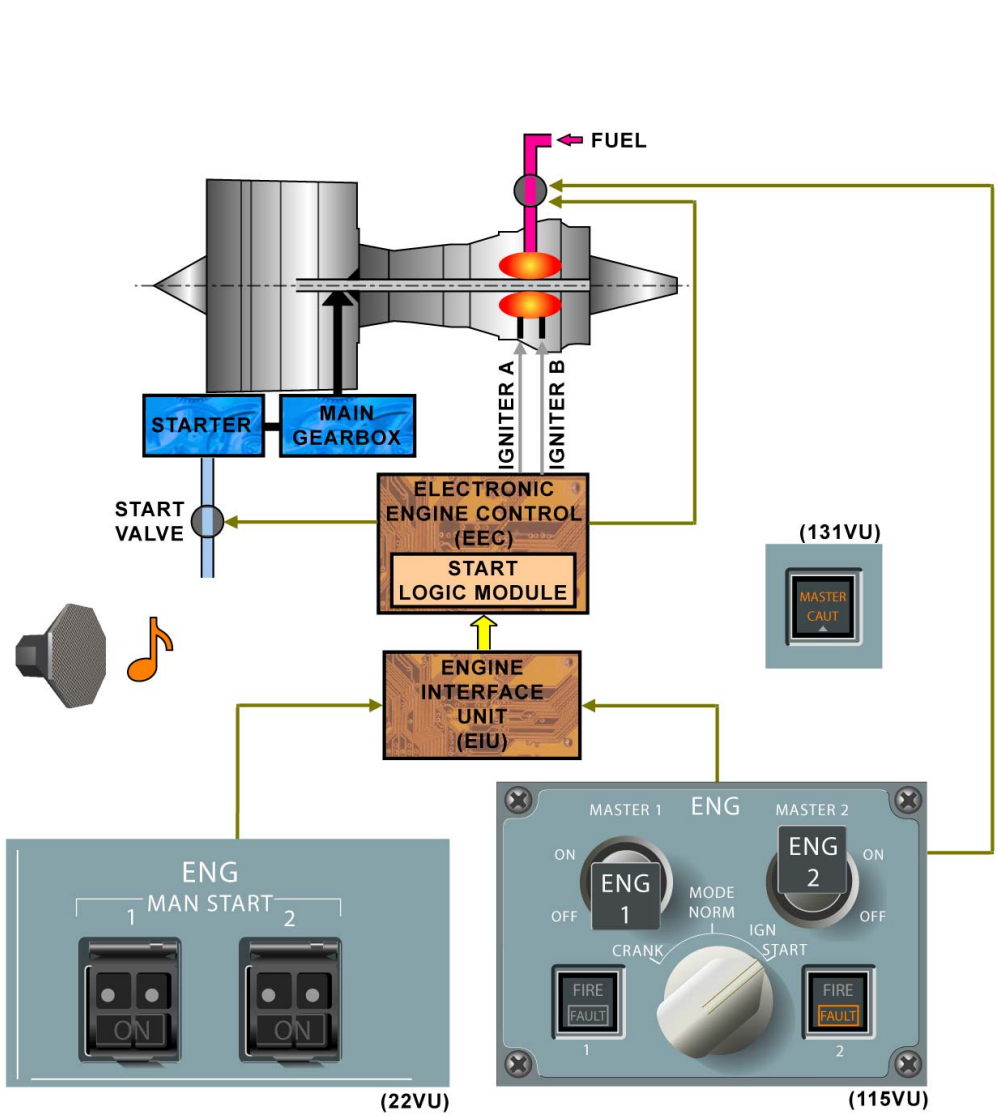
START VALVE (NOT OPEN)

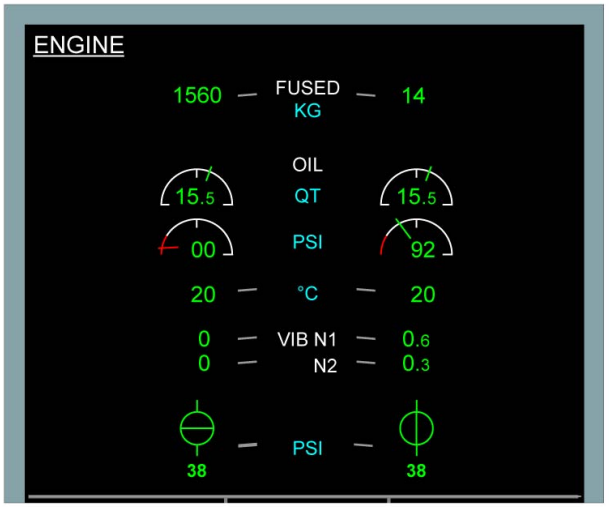
START FAILURES (ME) (3)

START VALVE (NOT CLOSED)

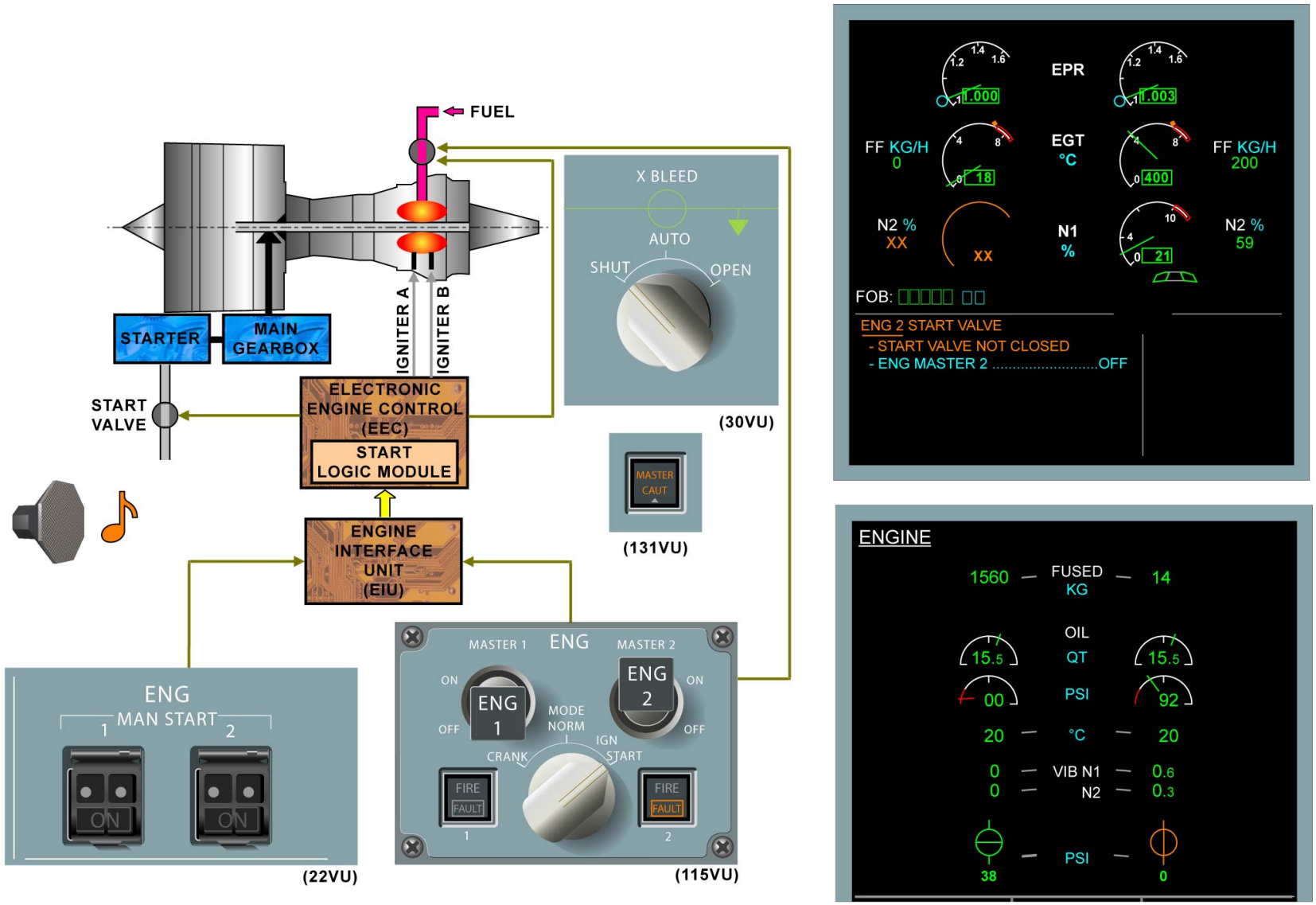
At 43% of N2, the FADEC sends a signal to close the start valve. If the start valve does not close, an aural warning operates. The MASTER CAUT and the ENG FAULT lights come on. An ECAM message comes into view. You must do the START VALVE NOT CLOSED procedure. For this, you must remove all bleed sources that supply the faulty start valve. Set the APU BLEED P/B (if engine 1 is in use) to OFF.
Set the X BLEED selector to SHUT.
Set the MASTER lever to OFF, then set the MODE selector to NORM.
Restart is not permitted, and a maintenance procedure is necessary.

UGB13131 - U7ST0M0 - UM74D2IAE000003

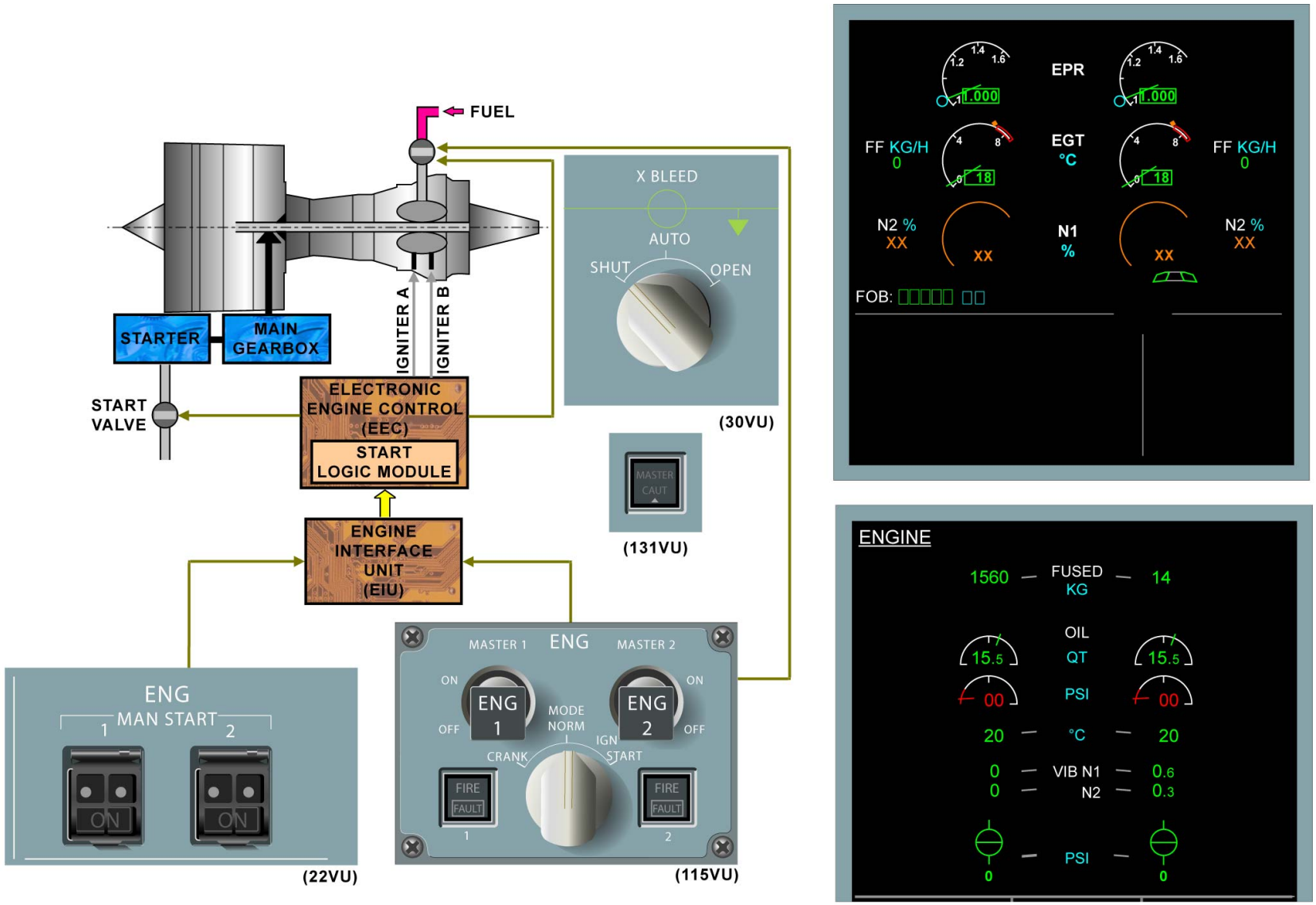




START VALVE (NOT CLOSED)



START VALVE (NOT CLOSED)



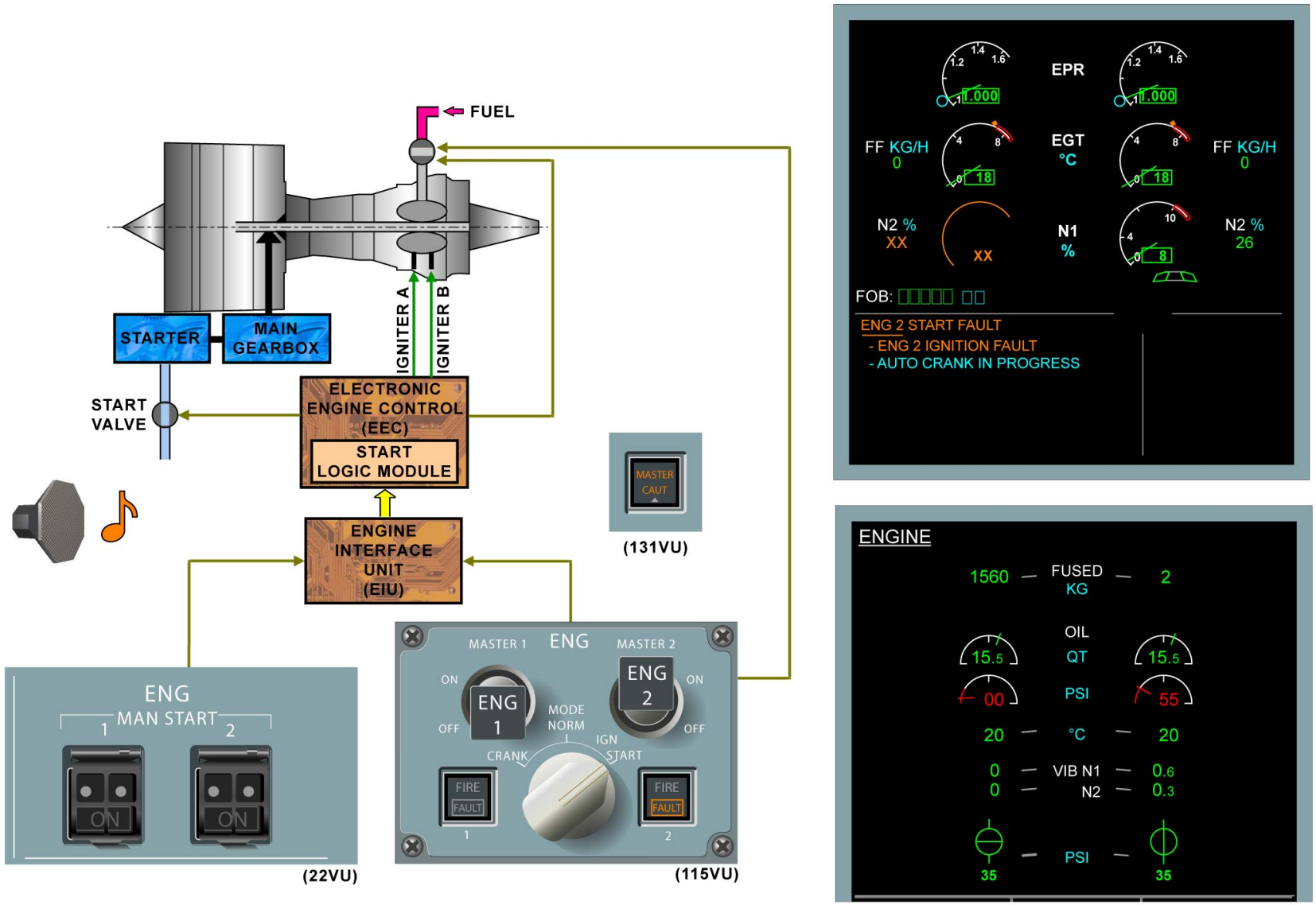
START VALVE (NOT CLOSED)

START FAILURES (ME) (3)

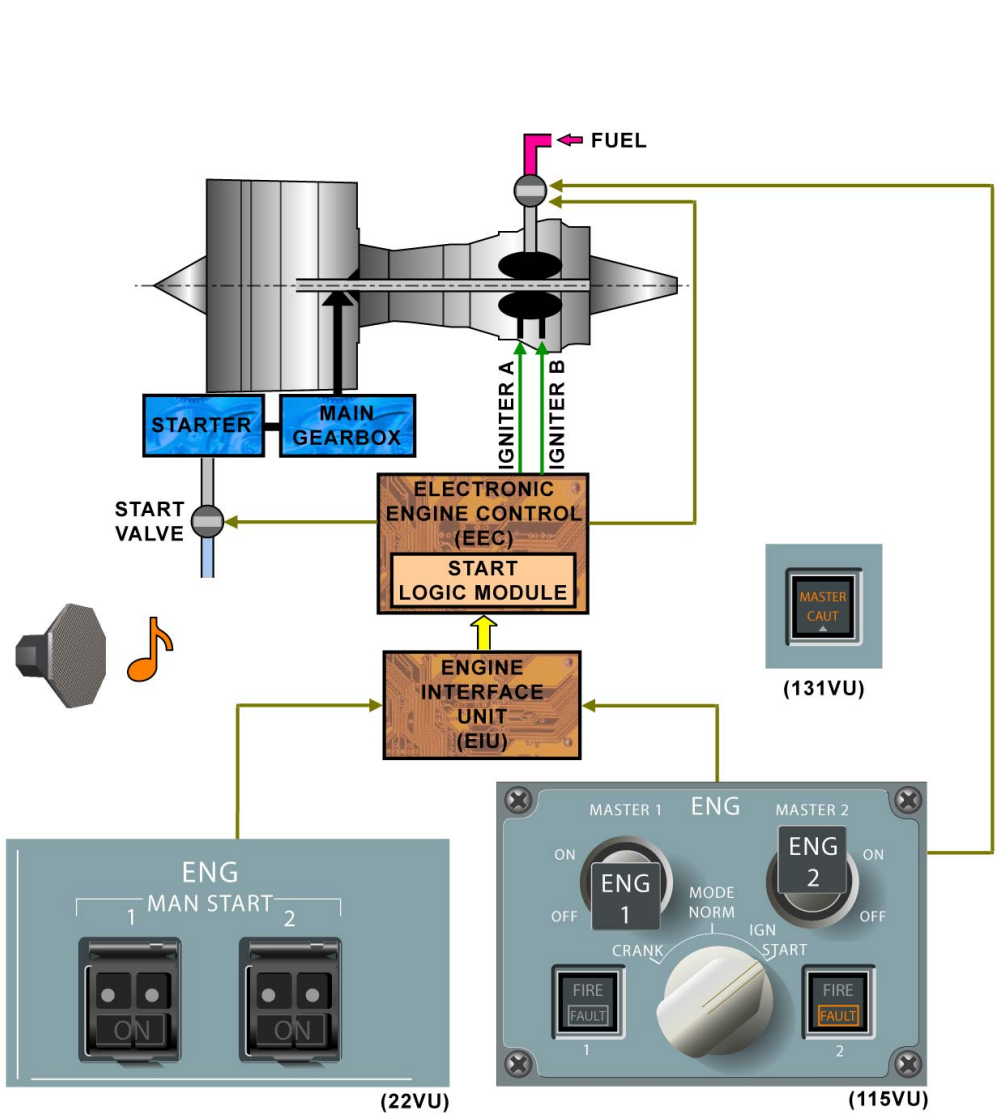
START FAULT (IGNITION AUTOMATIC MODE)

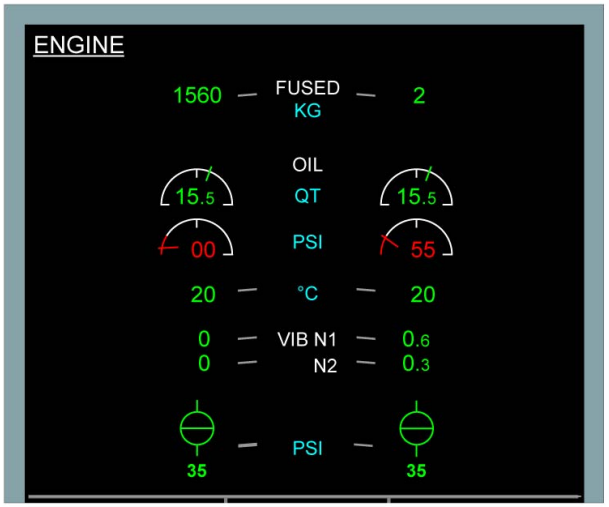
If an ignition fault occurs, an aural warning operates. The MASTER CAUT and the ENG FAULT lights come on. An ECAM message comes into view. The FADEC stops the fuel supply and ignition, and automatically supplies airflow to the engine.
The FADEC then closes the start valve. Then the MASTER lever must be set to OFF.

UGB13131 - U7ST0M0 - UM74D2IAE000003



START FAULT (IGNITION AUTOMATIC MODE)





START FAULT (IGNITION AUTOMATIC MODE)

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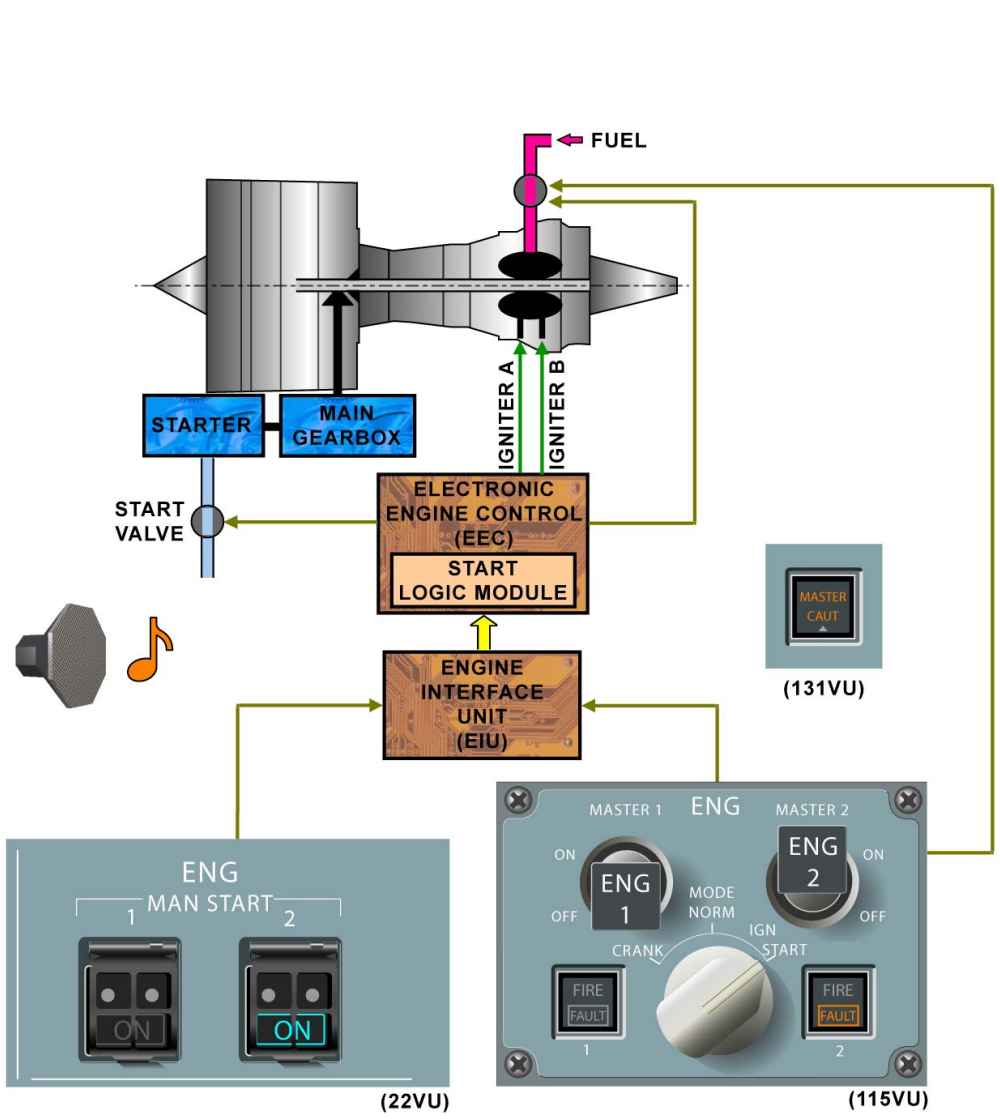
UGB13131 - U7ST0M0 - UM74D2IAE000003

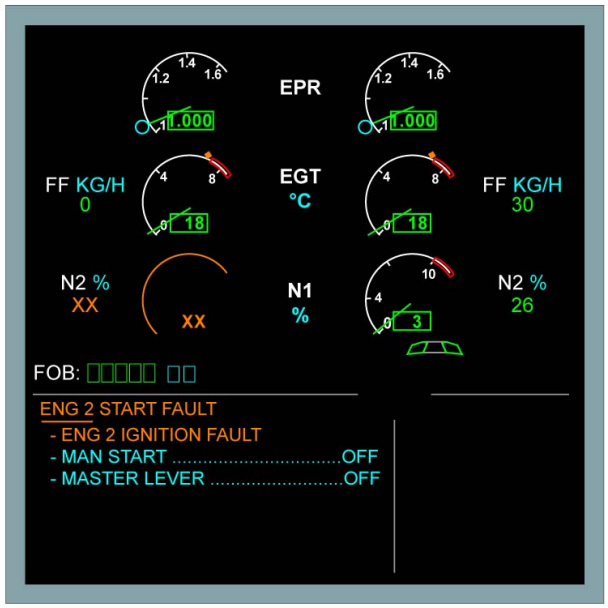
START FAILURES (ME) (3)

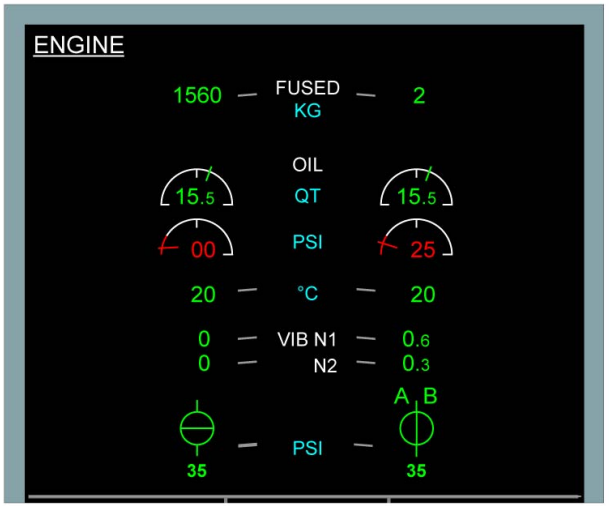
START FAULT (IGNITION MANUAL MODE)

If an IGNITION FAULT occurs, an aural warning operates. The MASTER CAUT and the ENG FAULT lights come on. An ECAM message comes into view. In manual start, the FADEC does not abort the start.
You must do the necessary procedure to stop the engine.

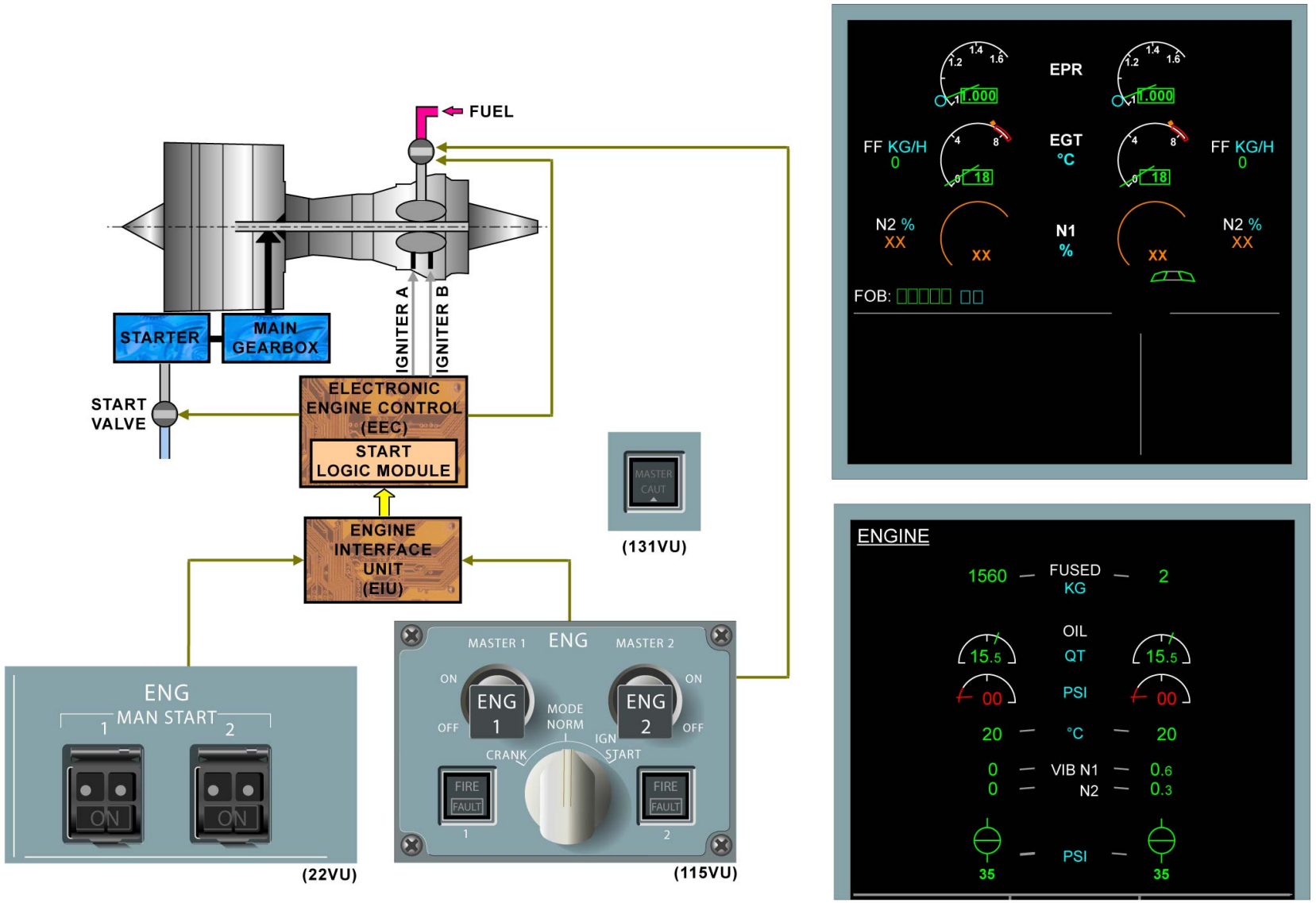
UGB13131 - U7ST0M0 - UM74D2IAE000003







START FAULT (IGNITION MANUAL MODE)



START FAULT (IGNITION MANUAL MODE)

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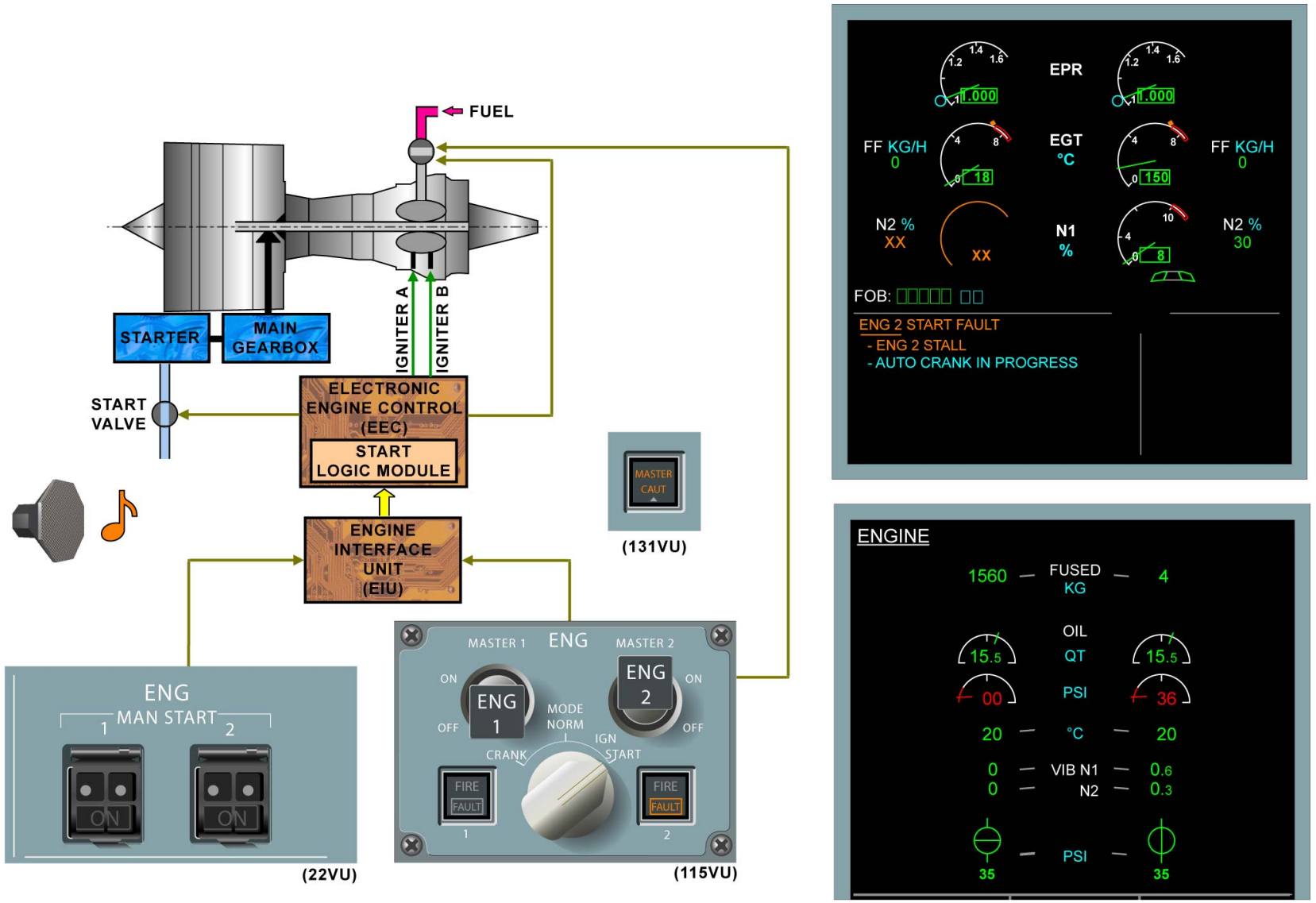
UGB13131 - U7ST0M0 - UM74D2IAE000003

START FAILURES (ME) (3)

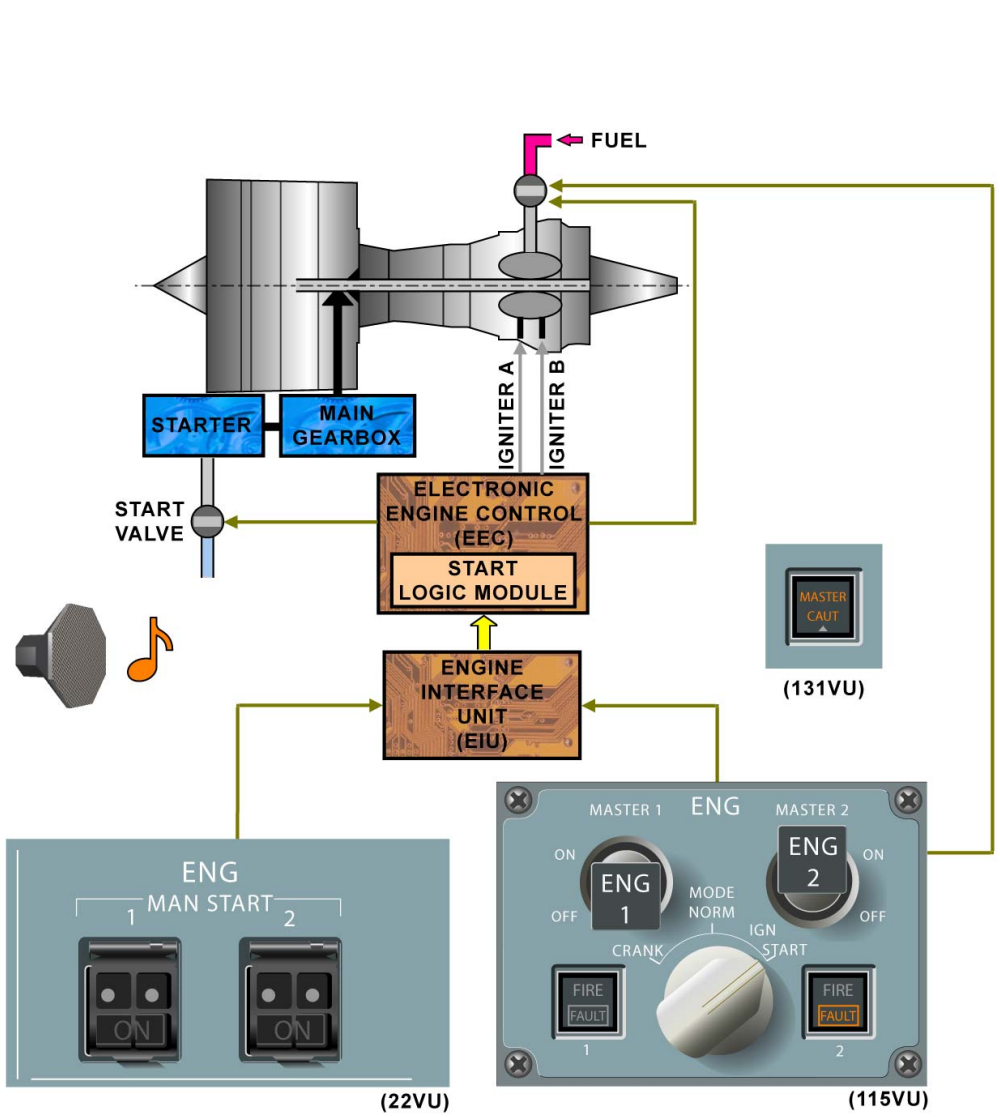
START FAULT (STALL AUTOMATIC MODE)

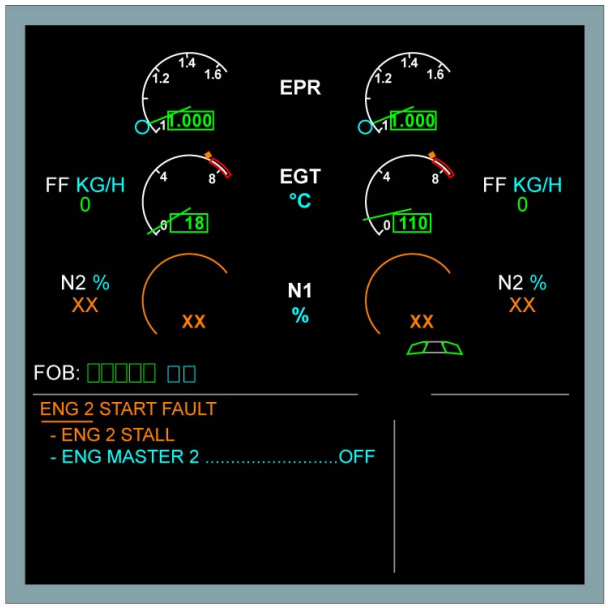
If there is a sensed stall or Exhaust Gas Temperature (EGT) overlimit, the FADEC auto-start control or the flight crew operations are identical.
When a stall or an EGT overlimit is sensed, an aural warning operates, the MASTER CAUT and the ENG FAULT lights come on. An ECAM message comes into view. The FADEC stops the fuel and the ignition, then a dry crank phase is automatically done.
After the auto-cranking, the FADEC aborts the start sequence. Then the MASTER lever must be set to OFF.

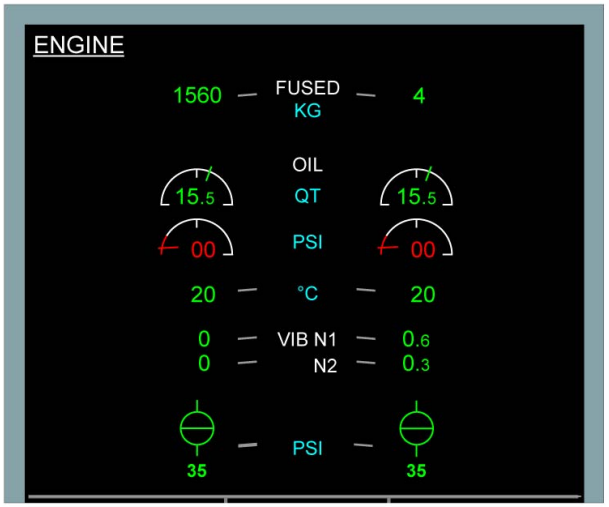
UGB13131 - U7ST0M0 - UM74D2IAE000003



START FAULT (STALL AUTOMATIC MODE)







START FAULT (STALL AUTOMATIC MODE)

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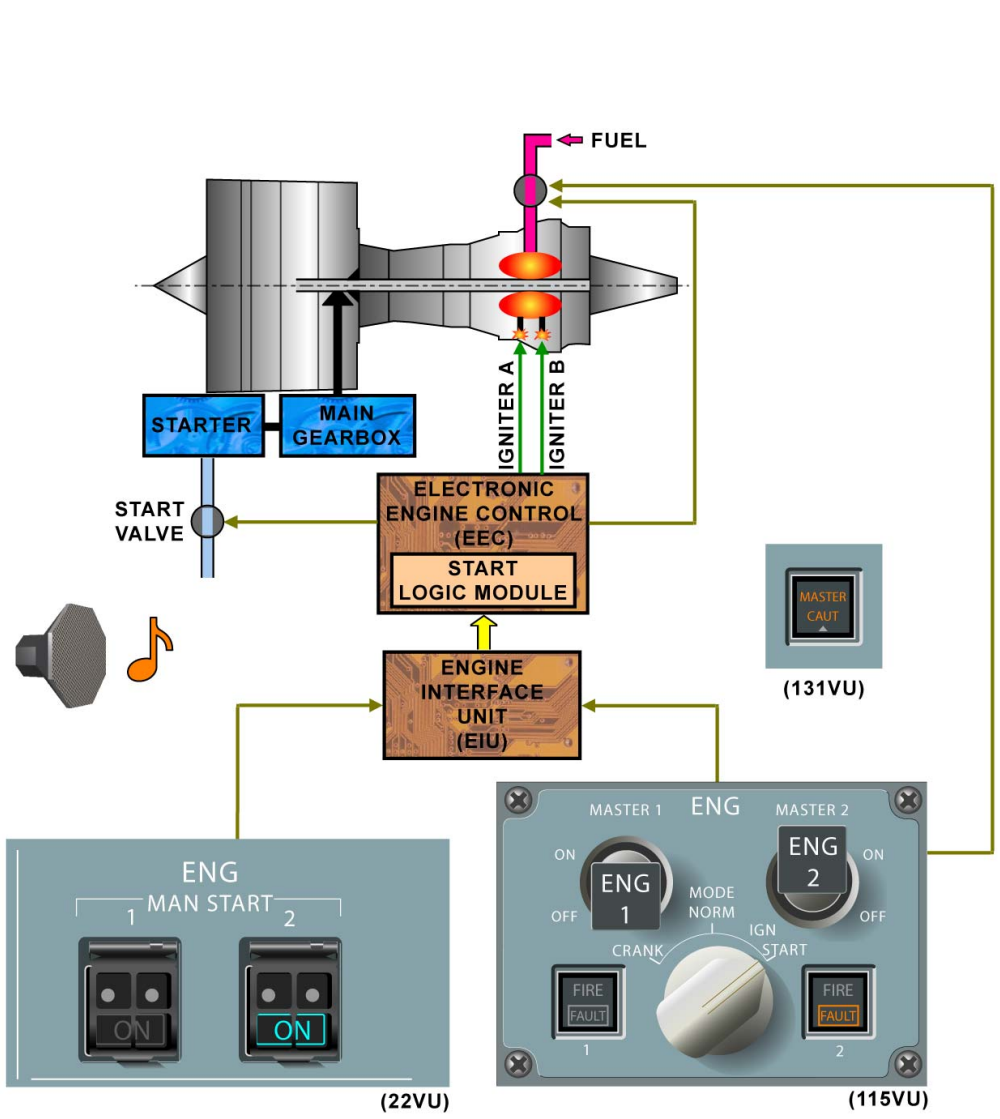
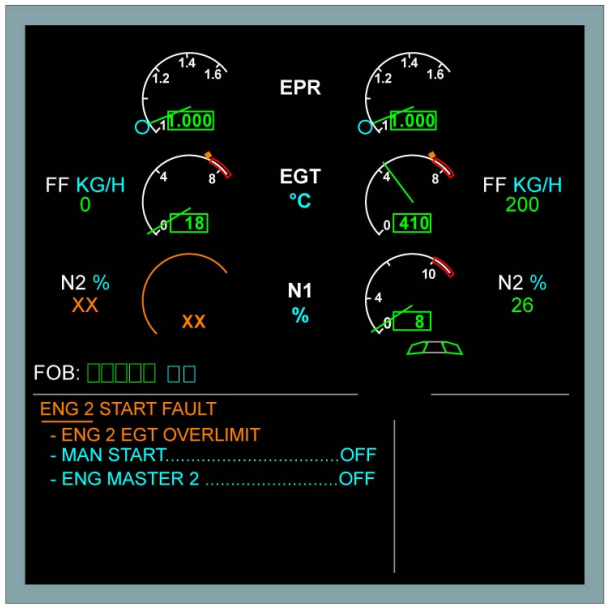
START FAILURES (ME) (3)

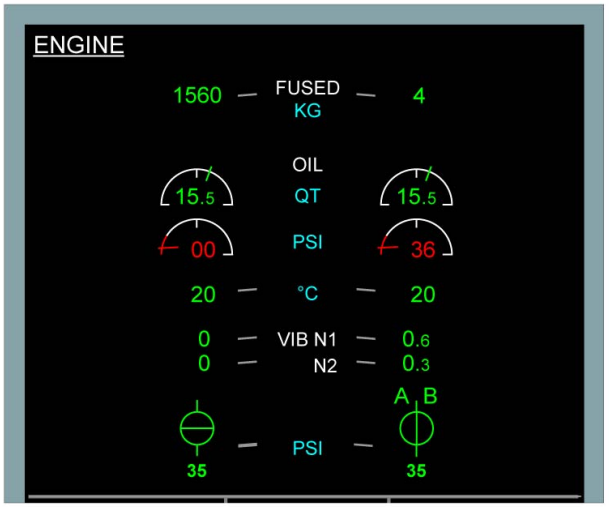
START FAULT (FAILURE DURING ENG MANUAL START MODE)

During the start, in case of EGT exceedance, an aural warning is triggered. The MASTER CAUT and the ENG FAULT lights come on. An ECAM message comes into view. In manual start, the FADEC does not abort the start.
The Crew operates the MASTER LEVER switch to OFF to stop the engine, as per ECAM procedure.

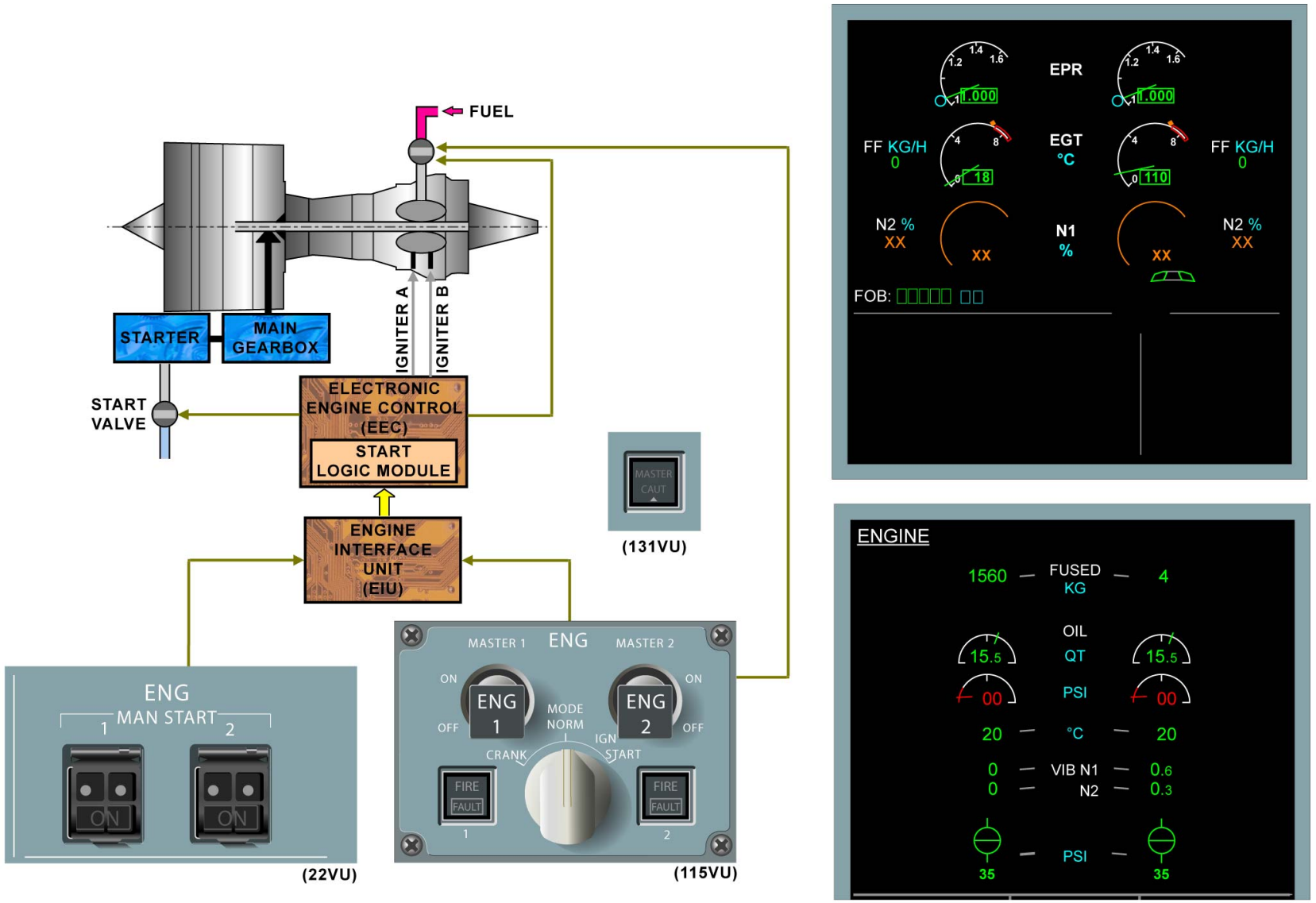
UGB13131 - U7ST0M0 - UM74D2IAE000003







START FAULT (FAILURE DURING ENG MANUAL START MODE)



START FAULT (FAILURE DURING ENG MANUAL START MODE)

EWD: FAILURE TITLE CONDITIONS	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNINGS
START VALVE (NOT OPEN)	SINGLE CHIME	MASTER CAUT	ENG	ENG FAULT LT
START VALVE (NOT CLOSED)				
START FAULT (IGNITION AUTOMATIC MODE)				
START FAULT (IGNITION MANUAL MODE)				
START FAULT (STALL AUTOMATIC MODE)				
START FAULT (EGT OVERLIMIT MANUAL MODE)				

START FAULT (FAILURE DURING ENG MANUAL START MODE)

START FAILURES (US) (3)

START VALVE (NOT OPEN)

If the start valve does not open, an aural warning sounds. The MASTER CAUTion and the ENGine FAULT light come on. An ECAM message appears. The Full Authority Digital Engine Control (FADEC) aborts the start sequence.
Another start with a manual operation of the start valve will be performed.
For this advise the ground crew to prepare for a start valve manual operation. Check that if the opposite engine is running, the X BLEED P/B is ON, or if APU is available, the APU BLEED P/B is ON.
Perform an automatic start, set the MODE selector to IGNition.
When the MASTER lever is set to ON, order the ground crew to open the start valve.
The start valve is opened.
When N2 reaches 43%, order the ground crew to close the start valve.
The start valve is closed, the engine is running now, continue with the normal procedure.

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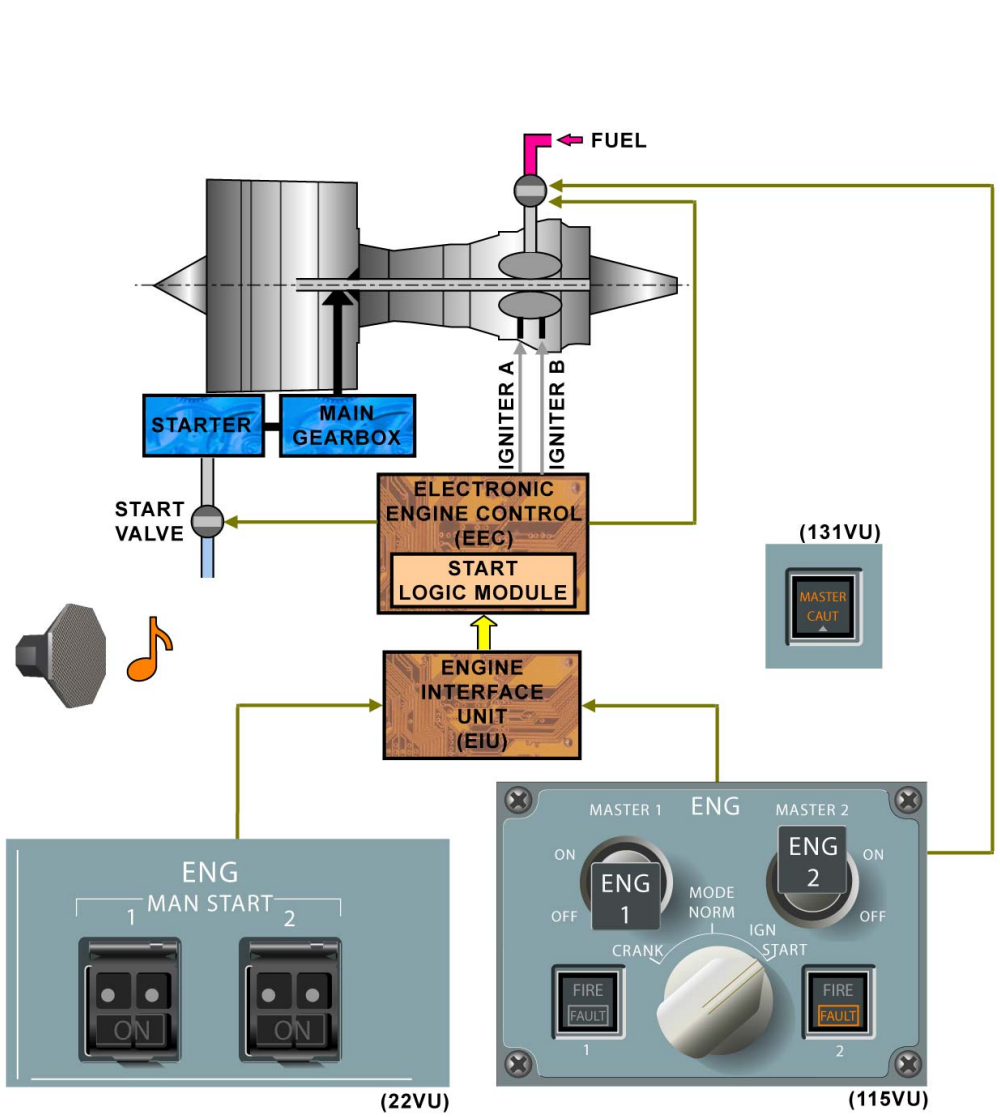
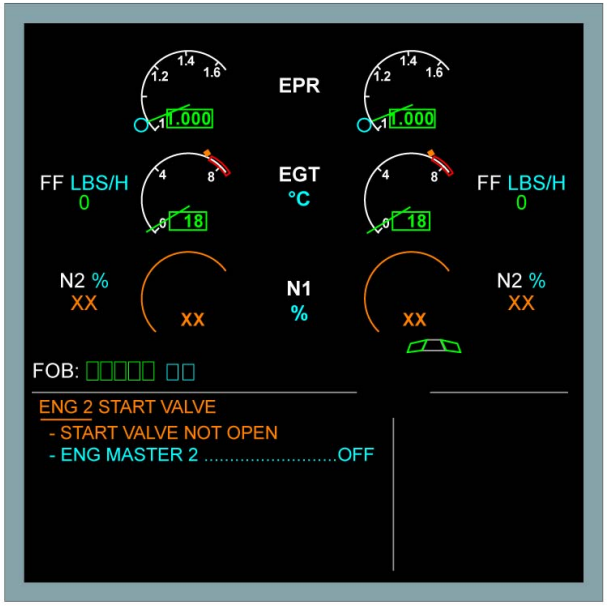
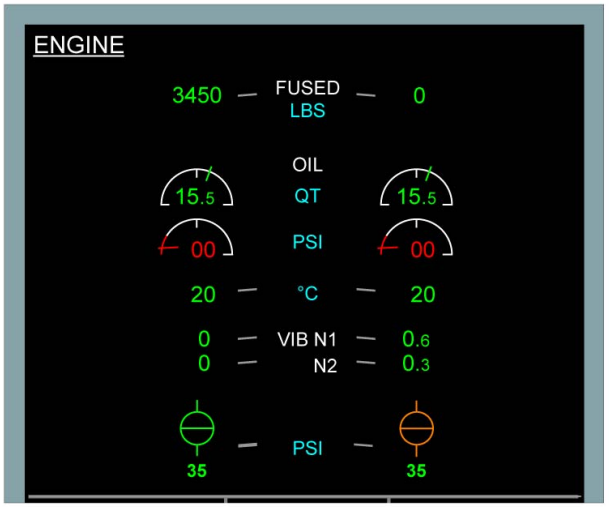
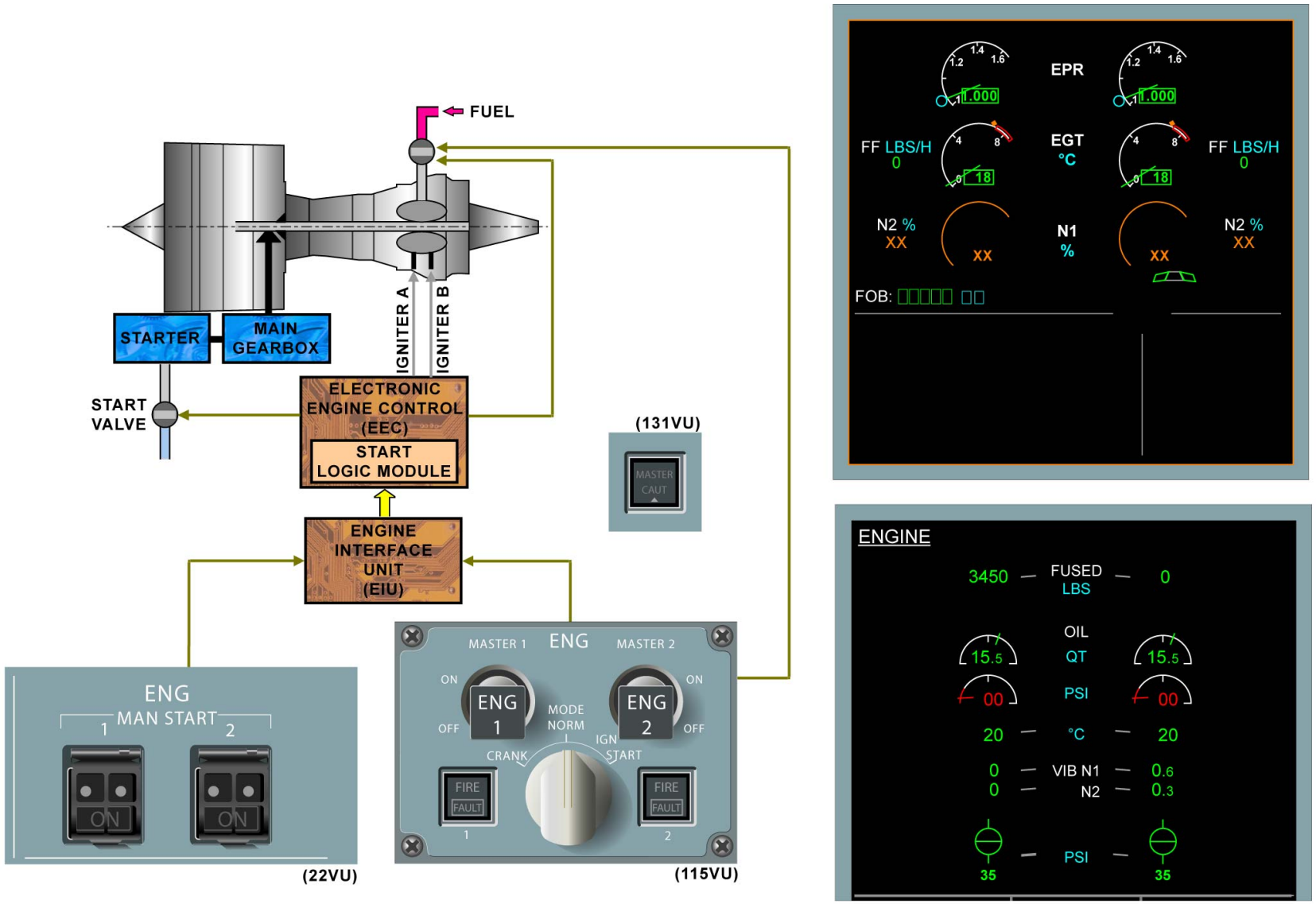






START VALVE (NOT OPEN)



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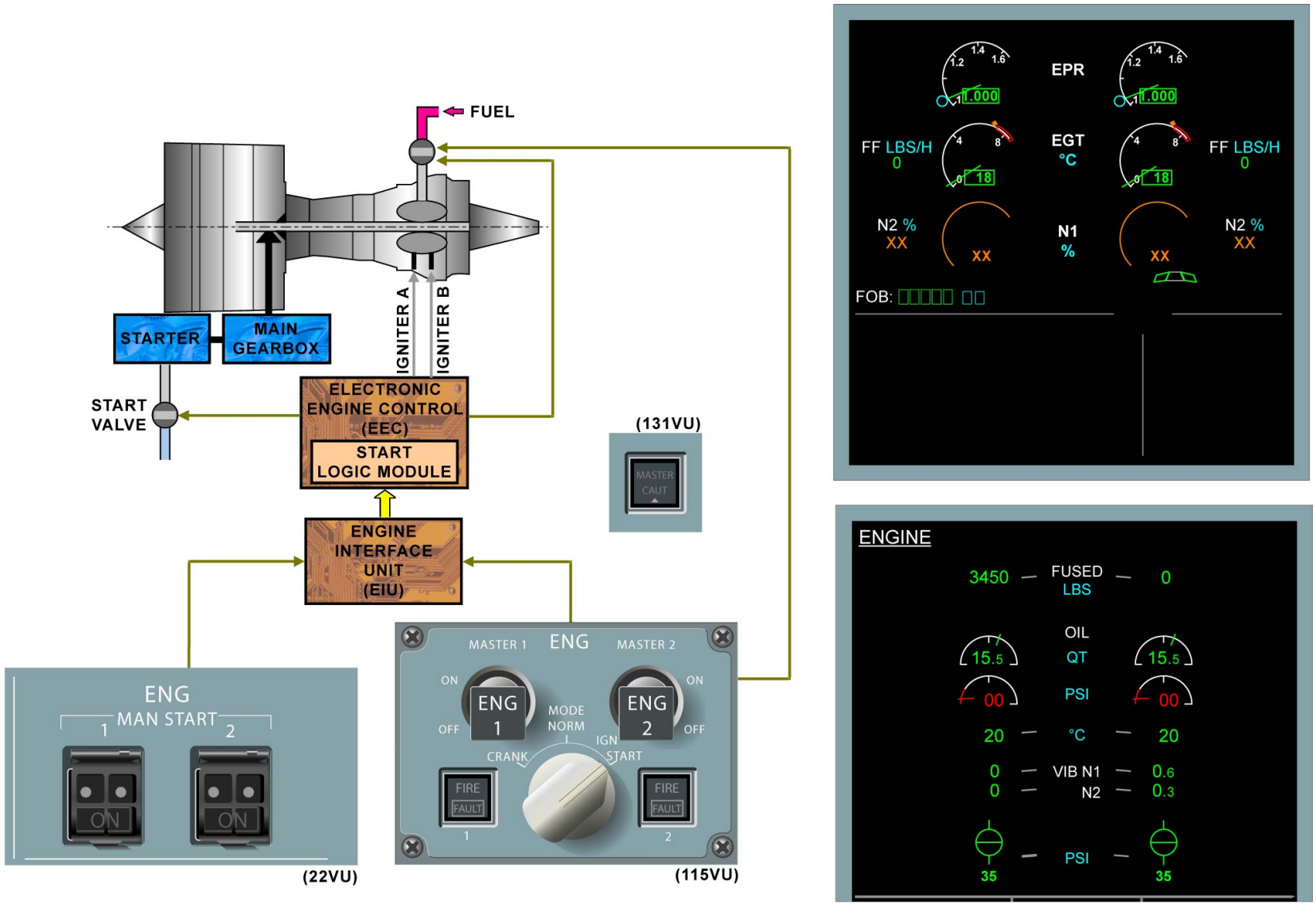

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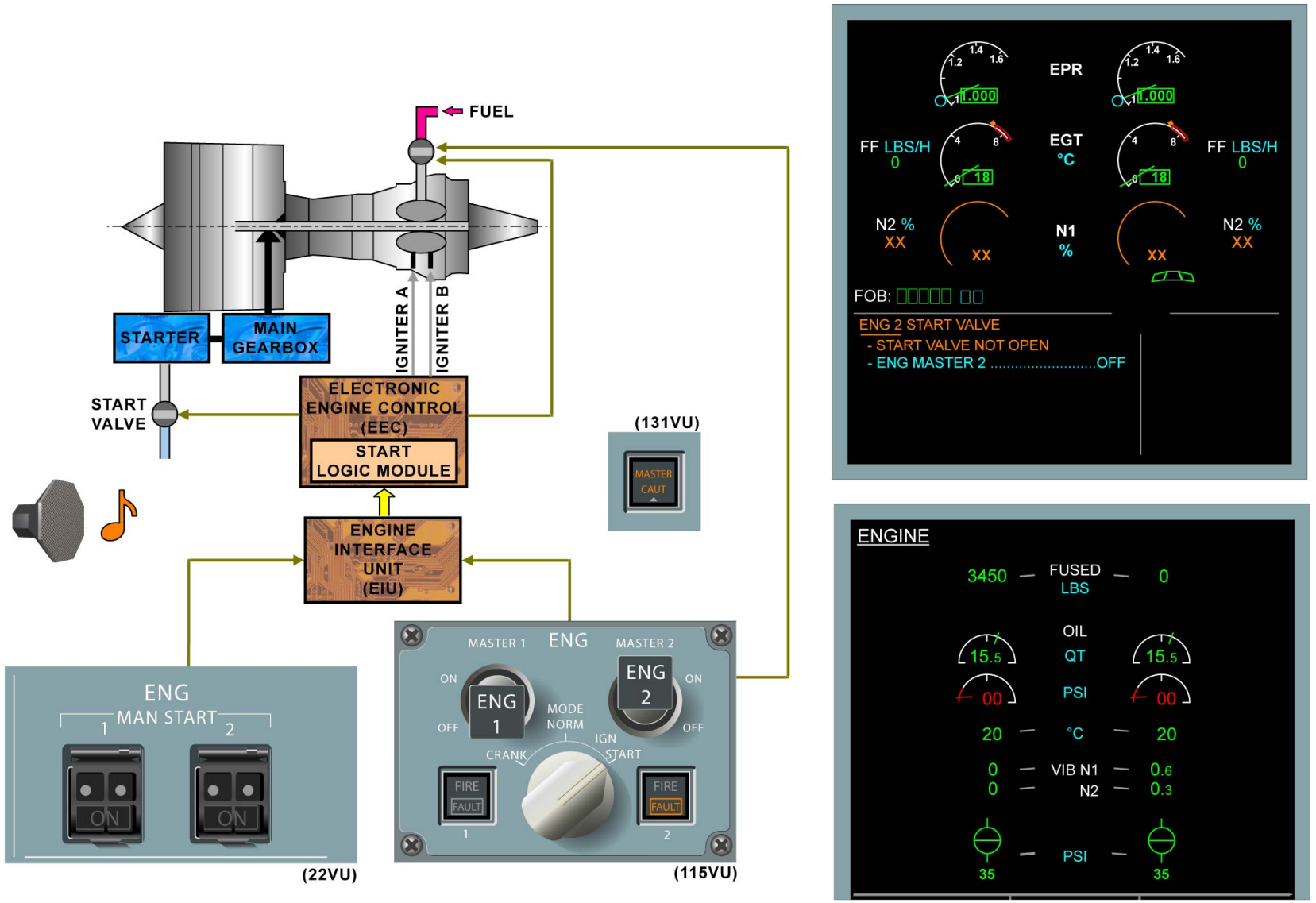

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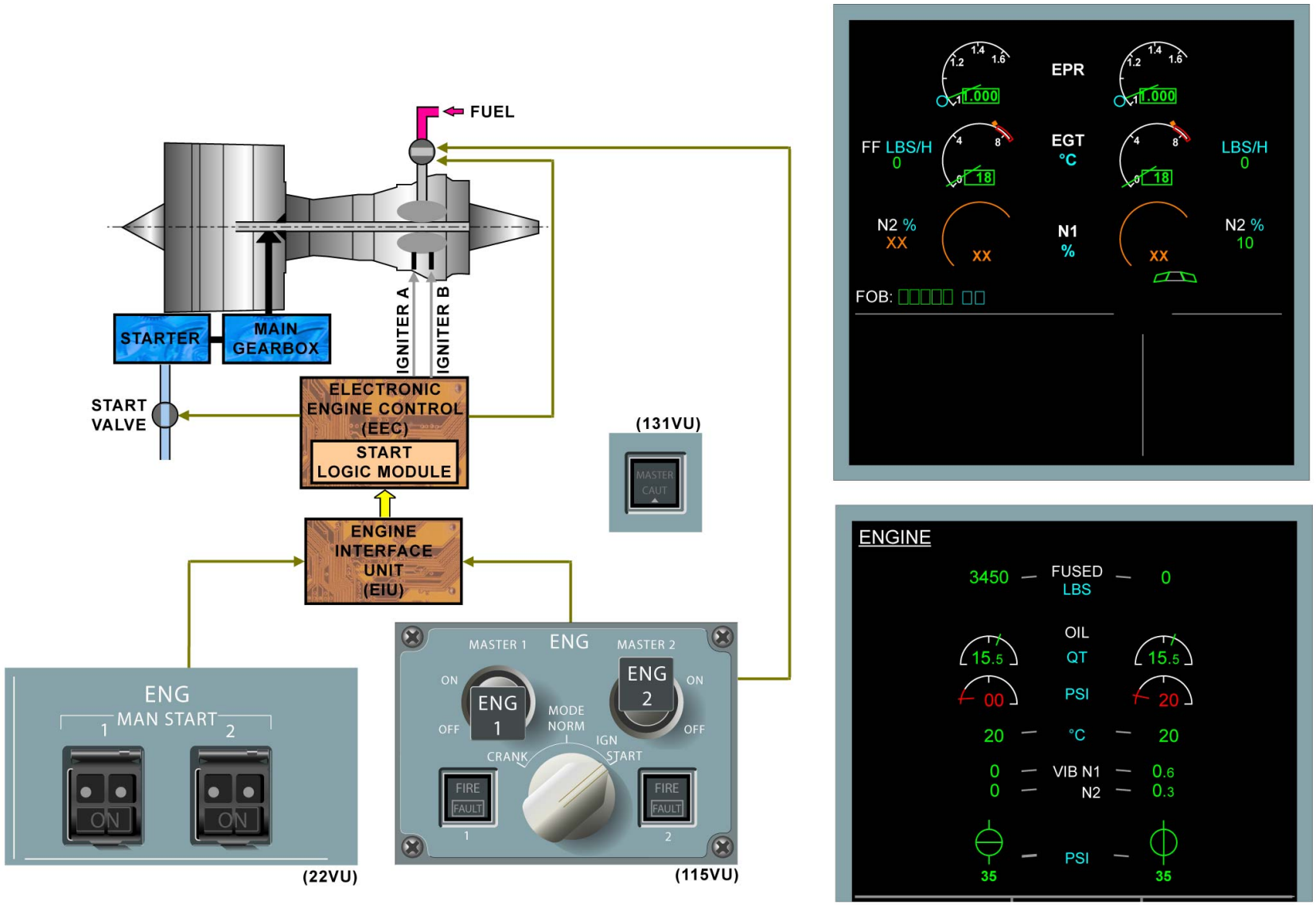

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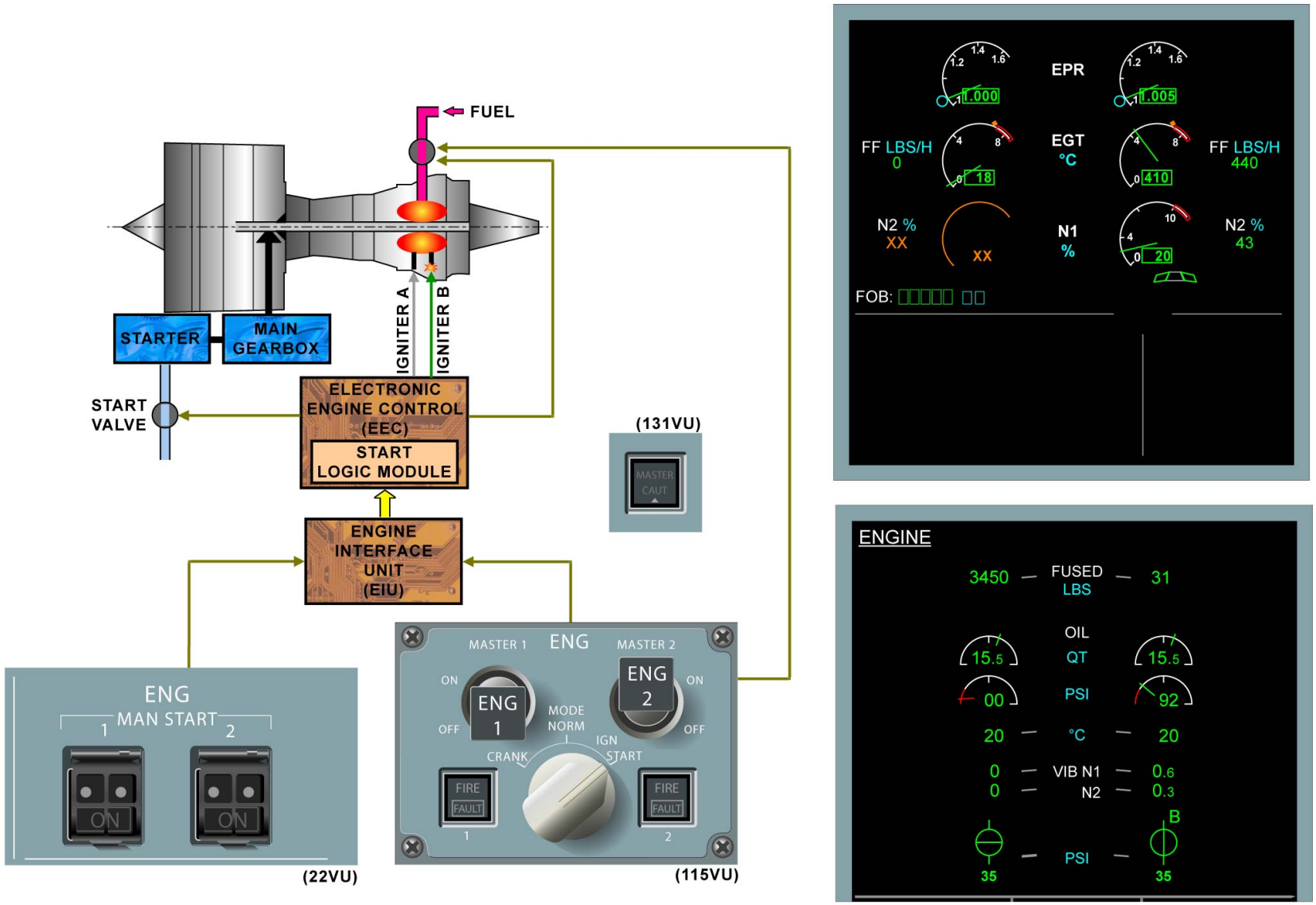

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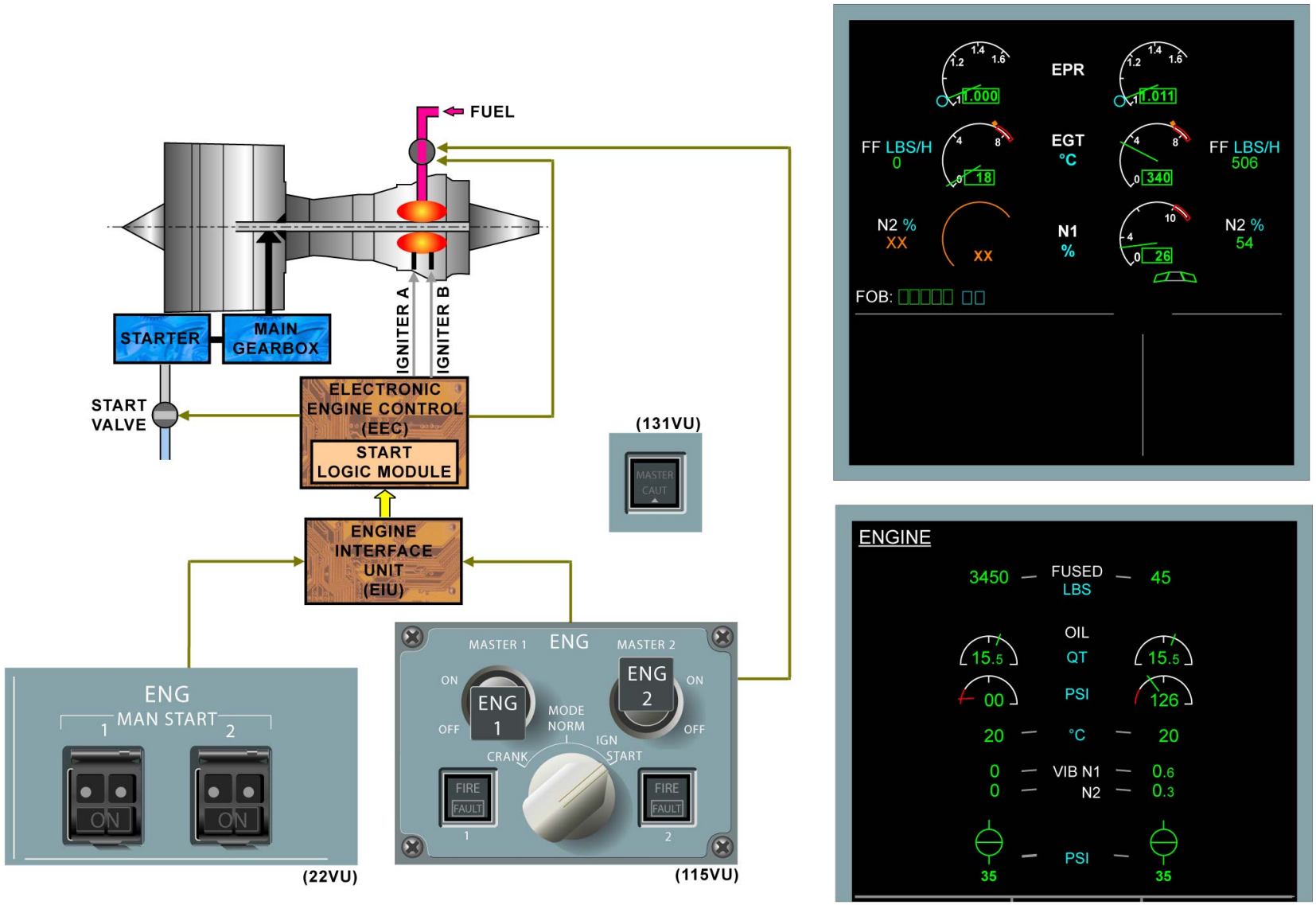

START VALVE (NOT OPEN)

START FAILURES (US) (3)

START VALVE (NOT CLOSED)

At 43% of N2, the FADEC sends a signal to close the start valve. If the start valve does not close, an aural warning sounds. The MASTER CAUT and the ENG FAULT light come on. An ECAM message appears. You must perform the START VALVE NOT CLOSED procedure.
For this, you must remove all bleed sources supplying the faulty start valve.
Set the APU BLEED P/B (if engine 1 is affected) to OFF.
Set the X BLEED selector to SHUT.
Set the MASTER lever to OFF, then set the MODE selector to NORM.
Restart is not allowed, and a maintenance action is required.

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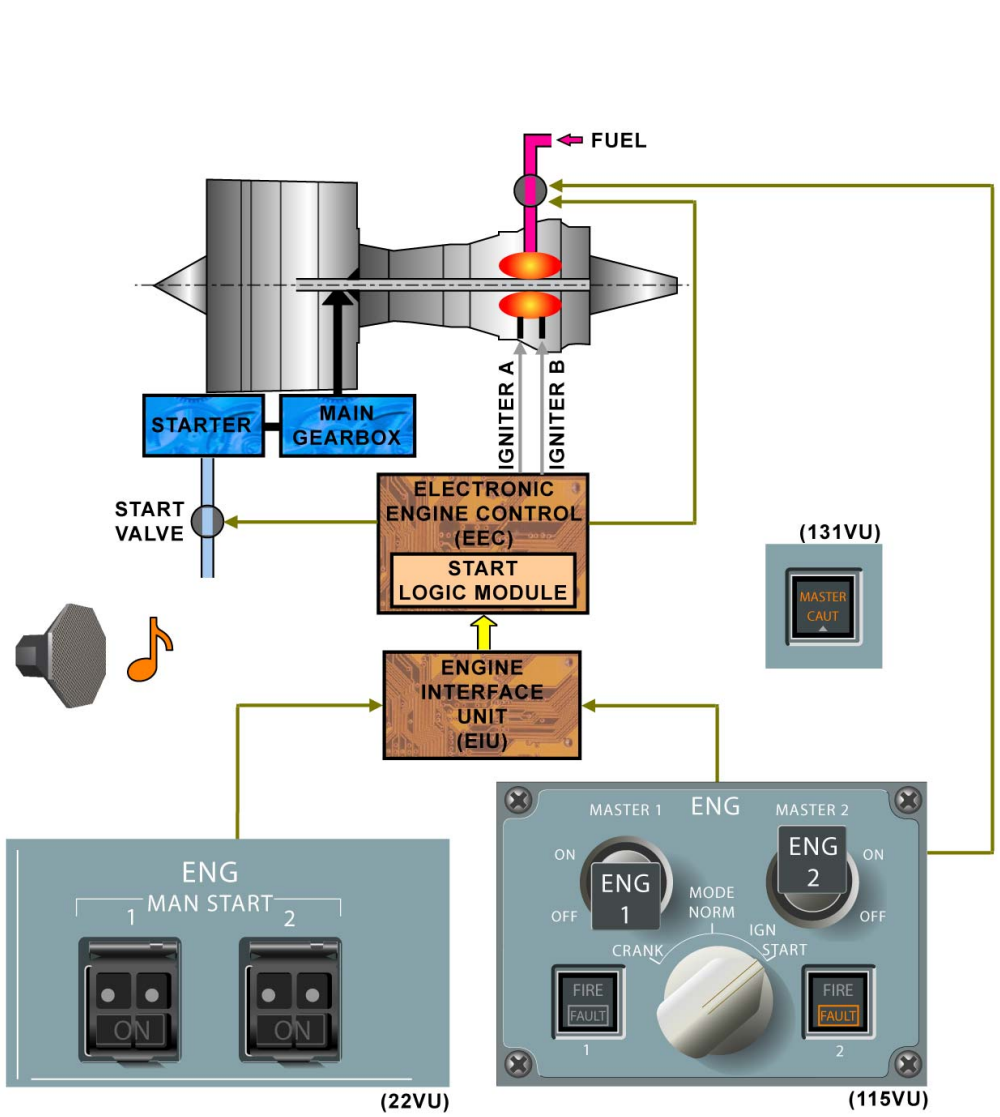
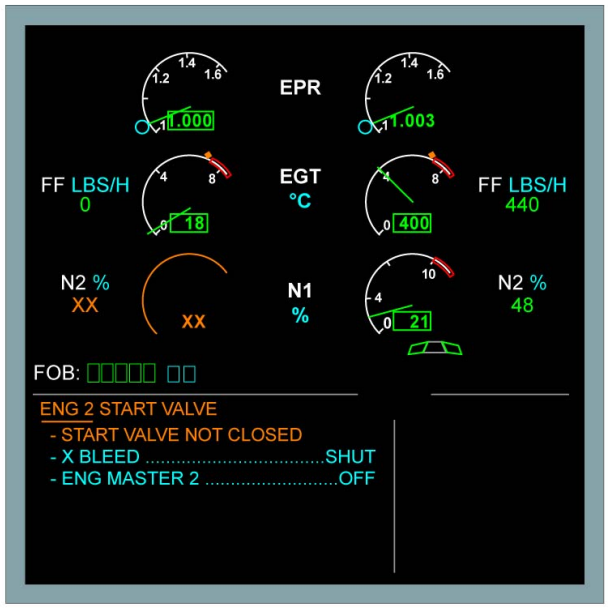
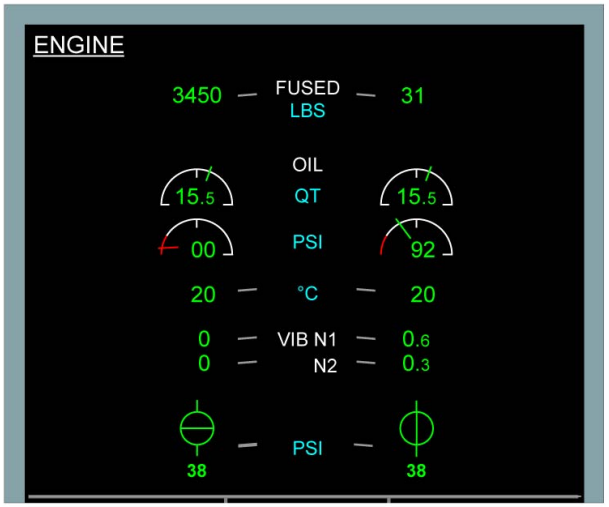
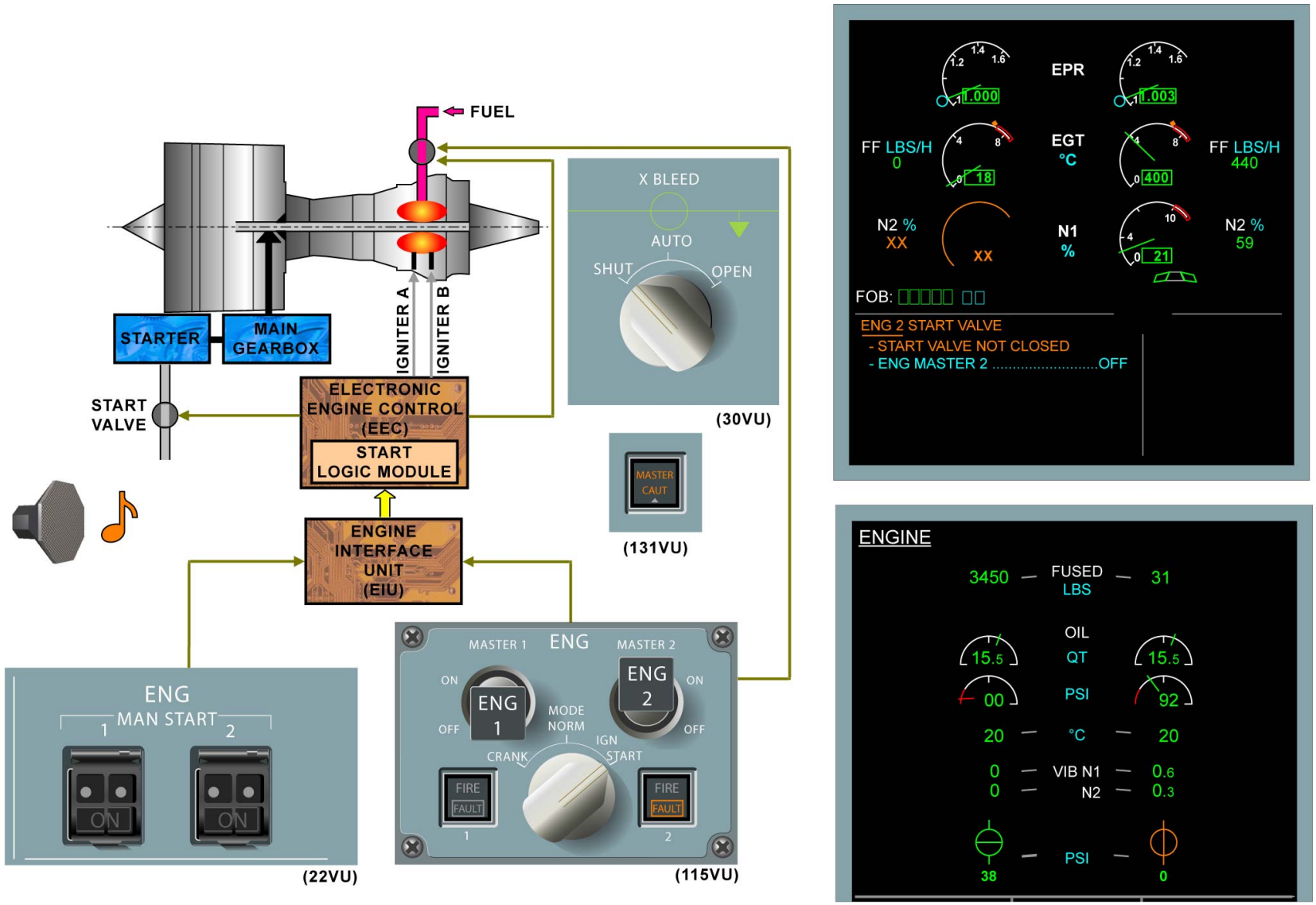


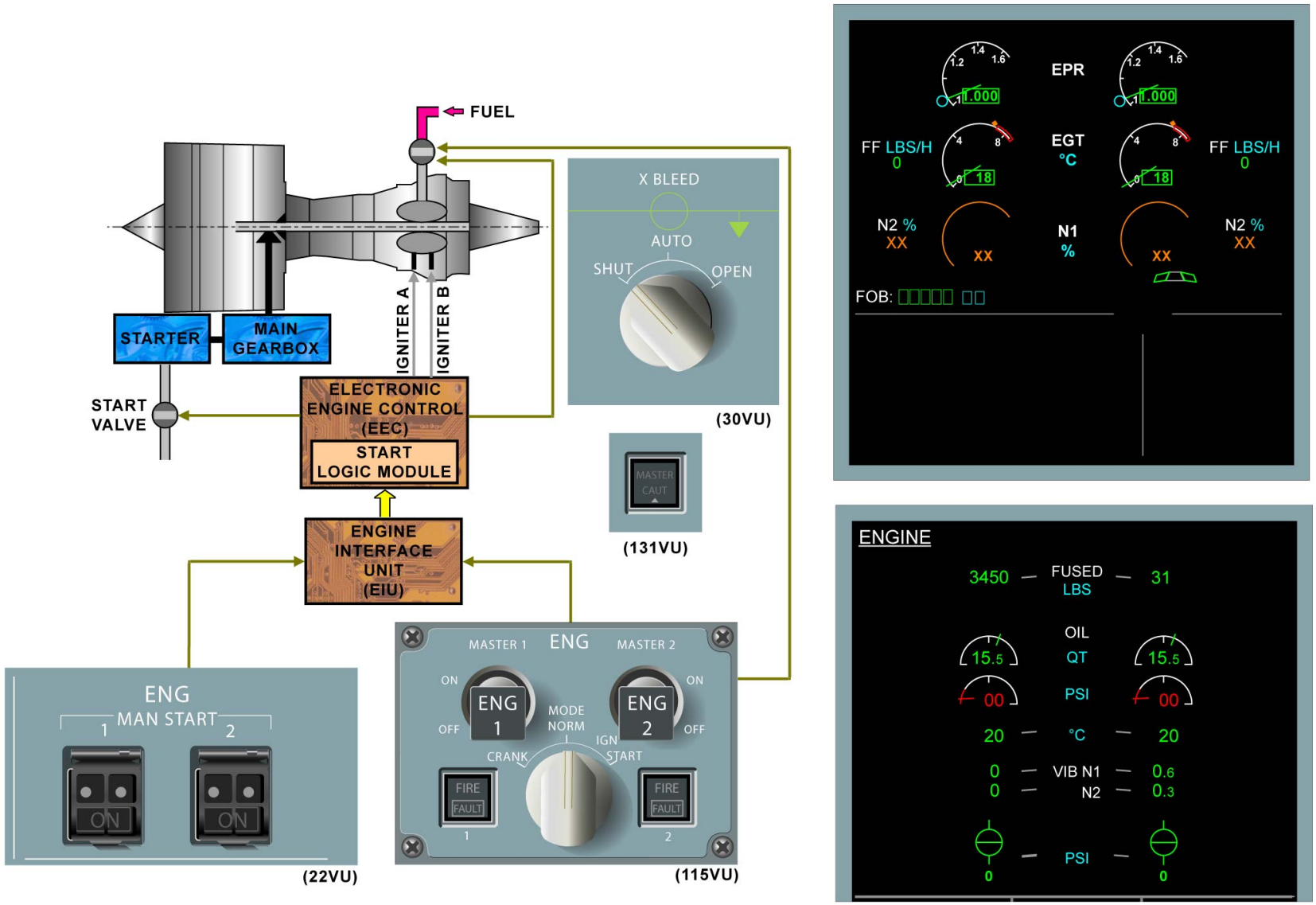




START VALVE (NOT CLOSED)



START VALVE (NOT CLOSED)



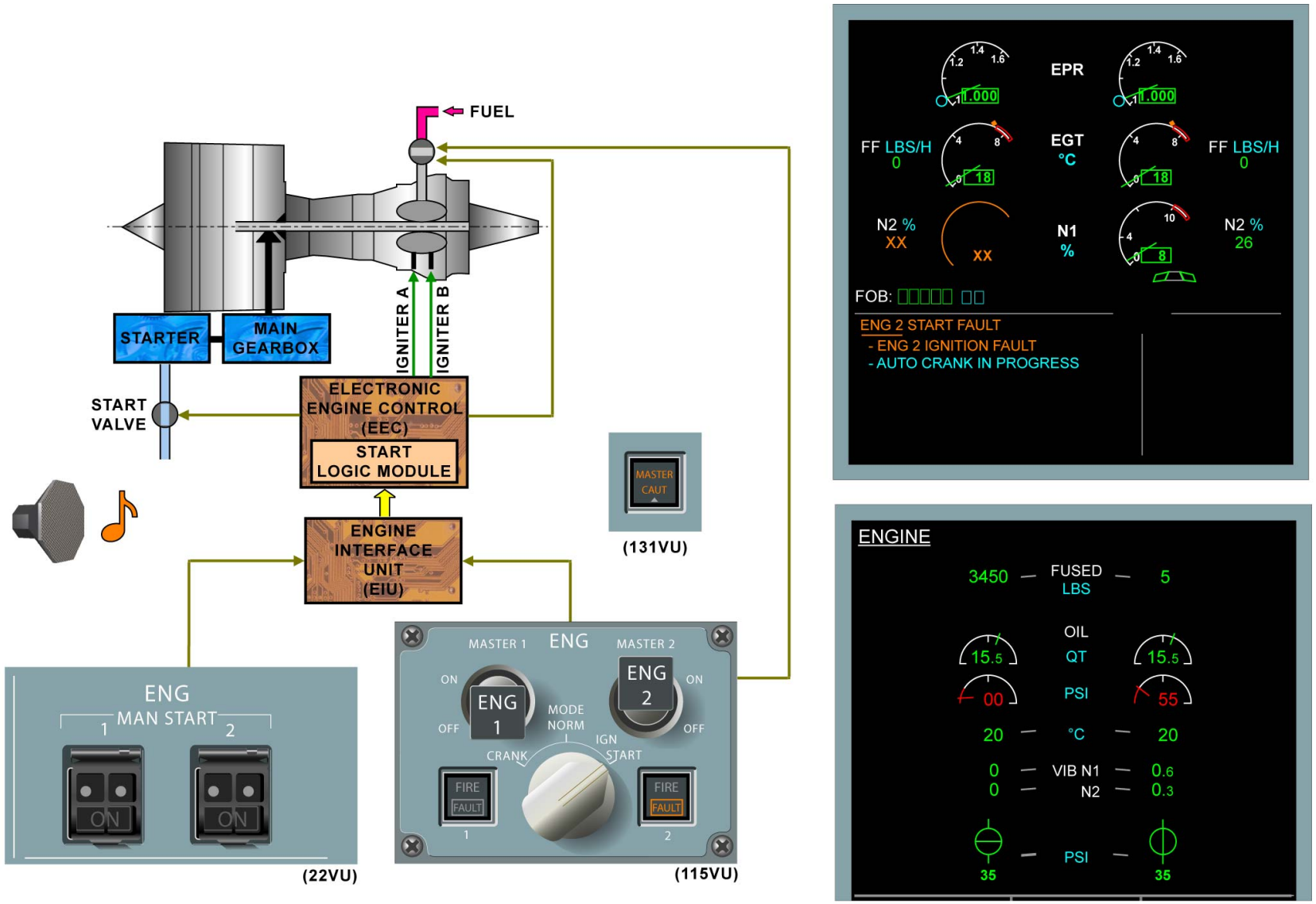
START VALVE (NOT CLOSED)

START FAILURES (US) (3)

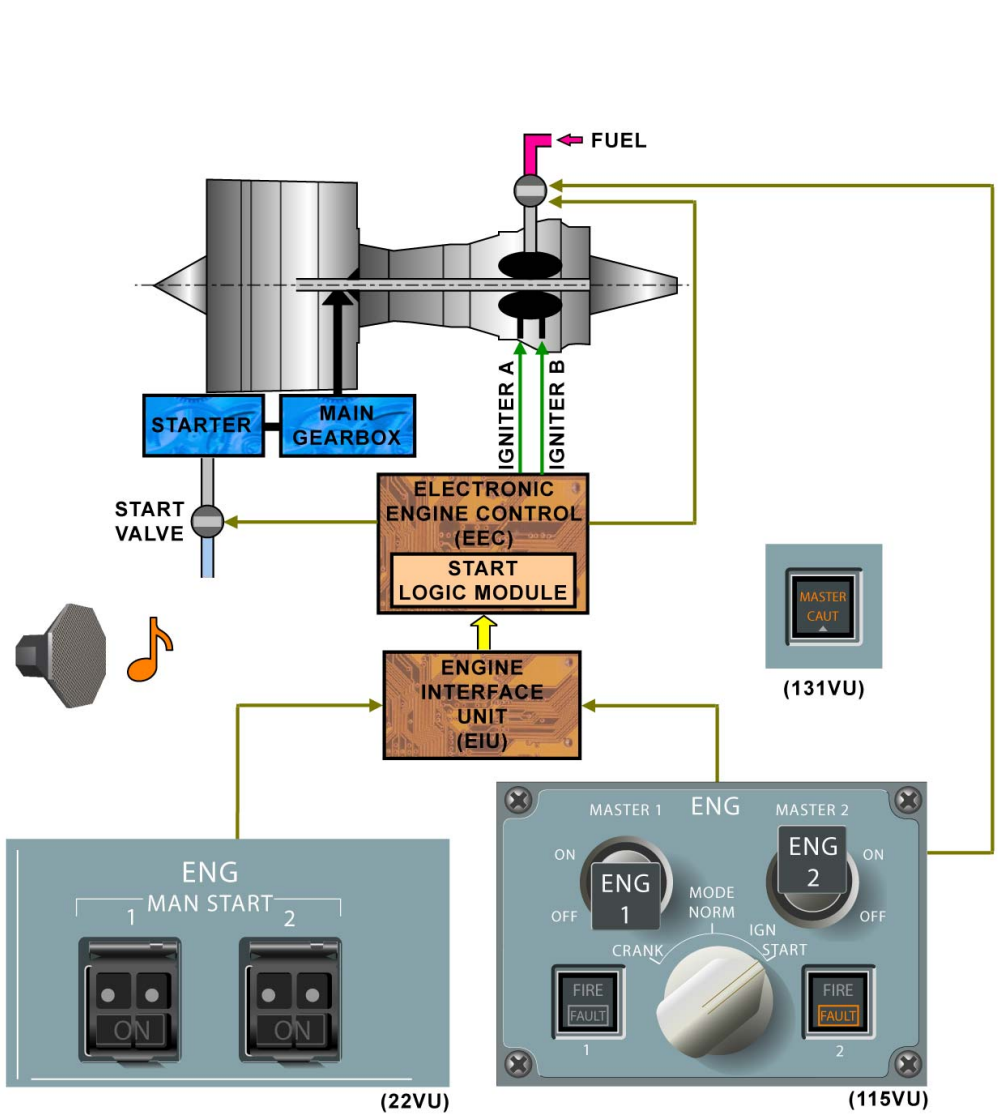
START FAULT (IGNITION AUTOMATIC MODE)

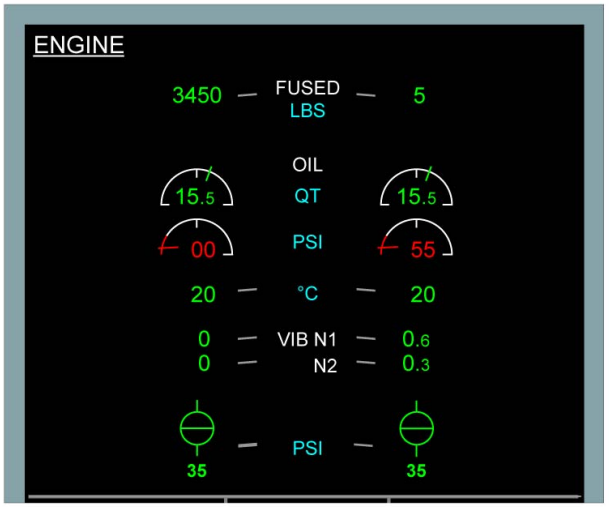
If an ignition fault occurs, an aural warning sounds. The MASTER CAUT and the ENG FAULT light come on. An ECAM message appears. The FADEC cuts the fuel supply and ignition, automatically ventilates the engine.
The FADEC then closes the start valve. Then the MASTER lever must be set to OFF.

UGB13131 - U7ST0M0 - UM74D2IAE000004



START FAULT (IGNITION AUTOMATIC MODE)





START FAULT (IGNITION AUTOMATIC MODE)

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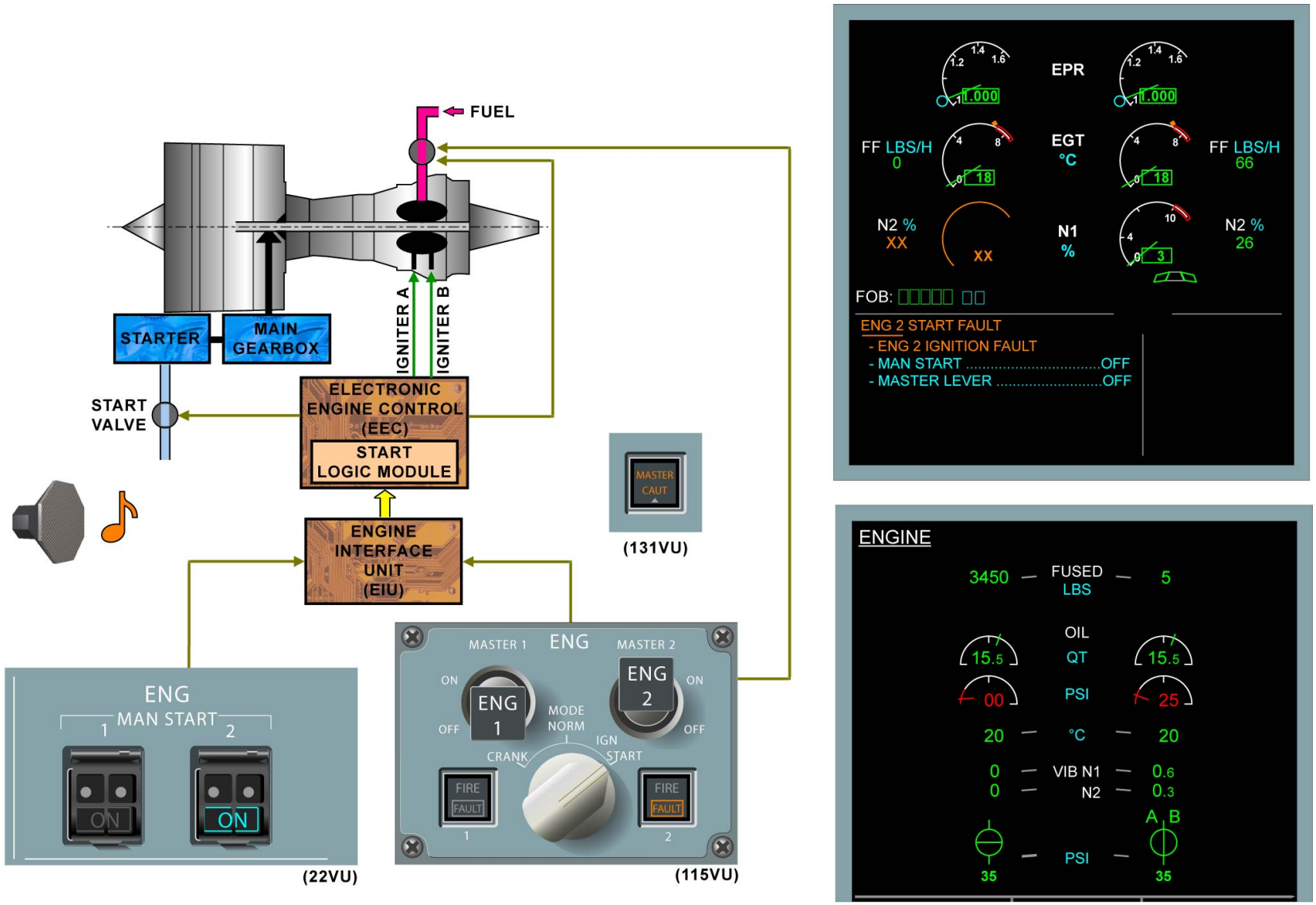
UGB13131 - U7ST0M0 - UM74D2IAE000004

START FAILURES (US) (3)

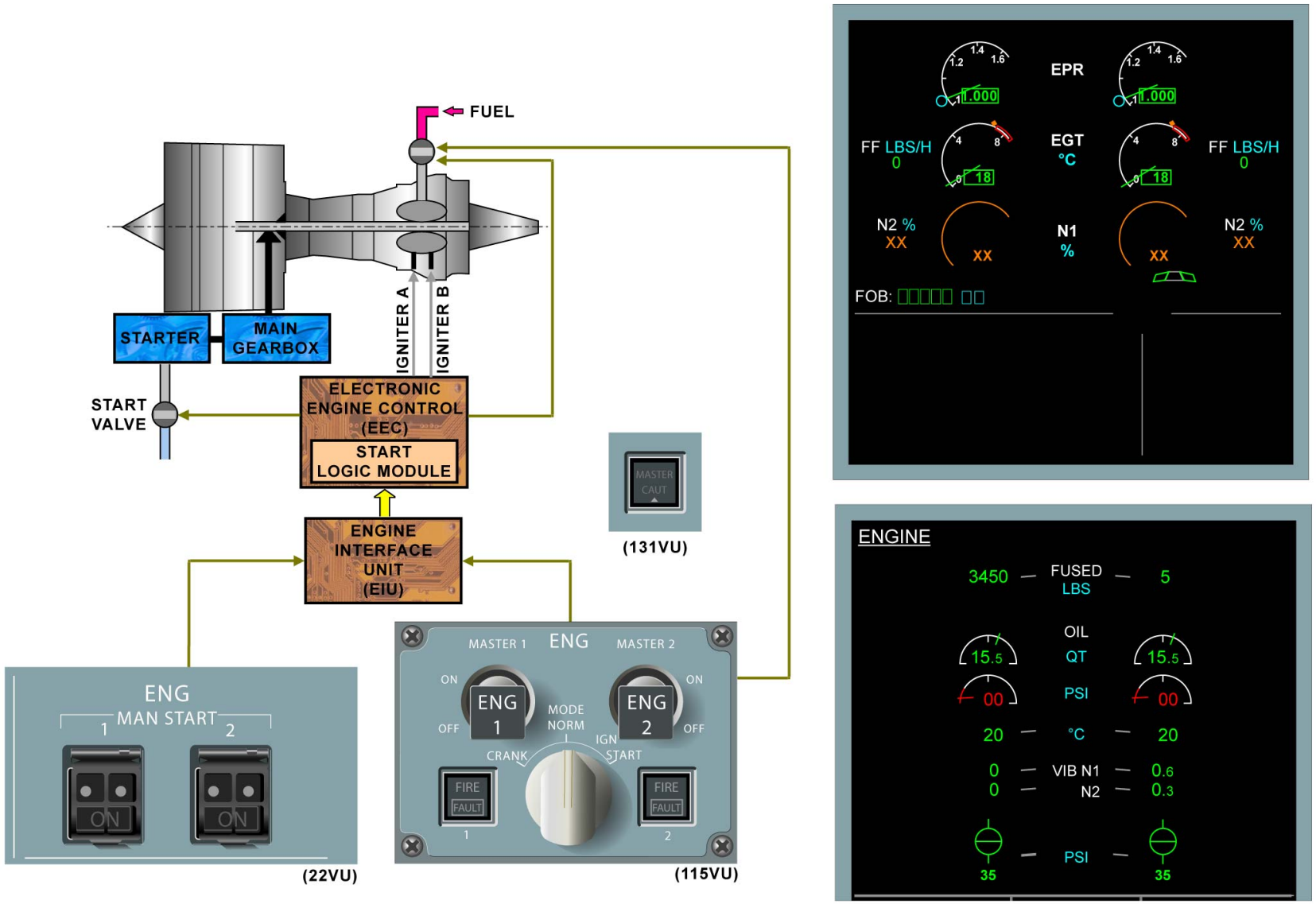
START FAULT (IGNITION MANUAL MODE)

If an ignition fault occurs, an aural warning sounds. The MASTER CAUT and the ENG FAULT light come on. An ECAM message appears. In manual start, the FADEC does not abort the start.
You must perform the action necessary to shut down the engine.

UGB13131 - U7ST0M0 - UM74D2IAE000004



START FAULT (IGNITION MANUAL MODE)



START FAULT (IGNITION MANUAL MODE)

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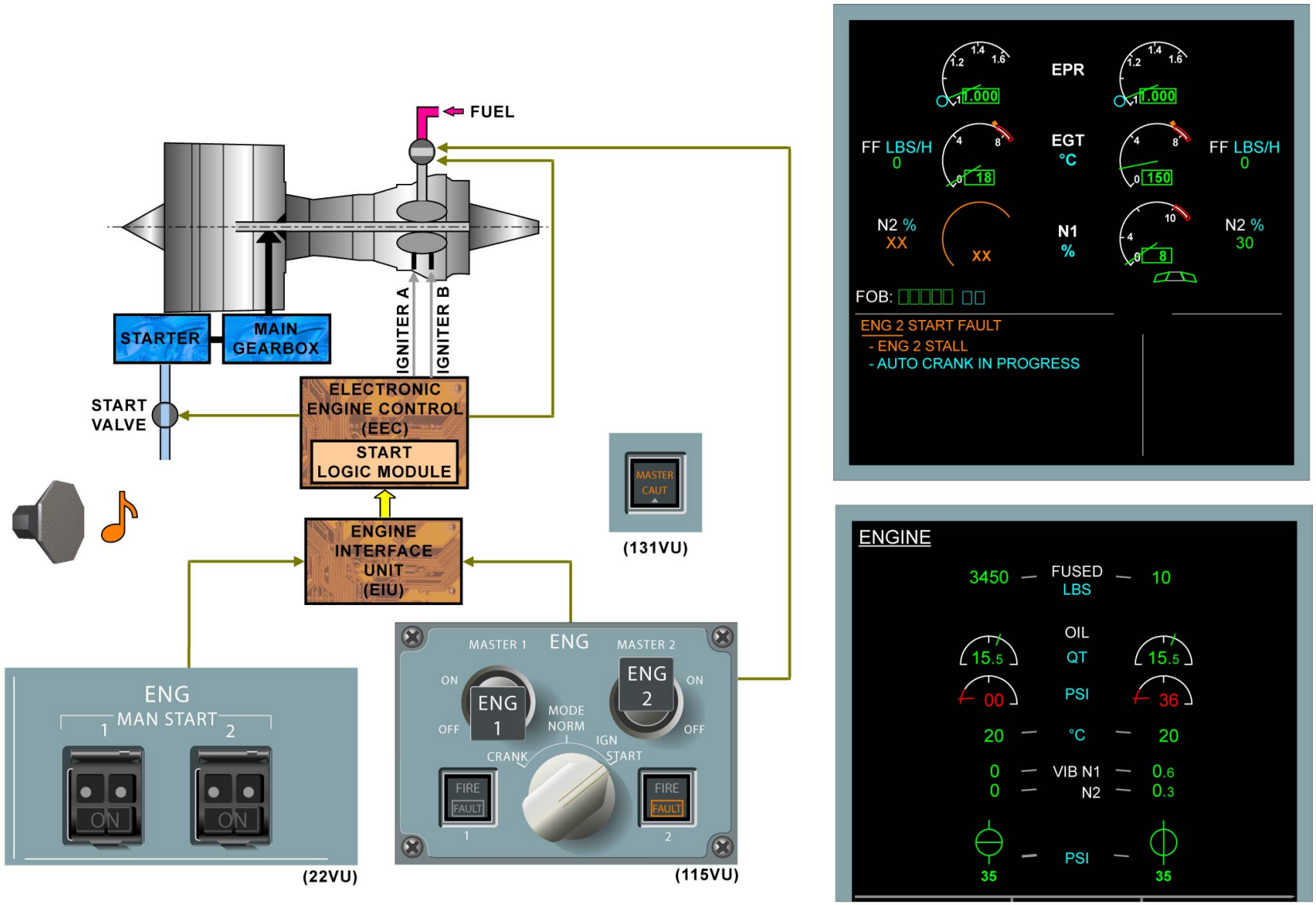
START FAILURES (US) (3)

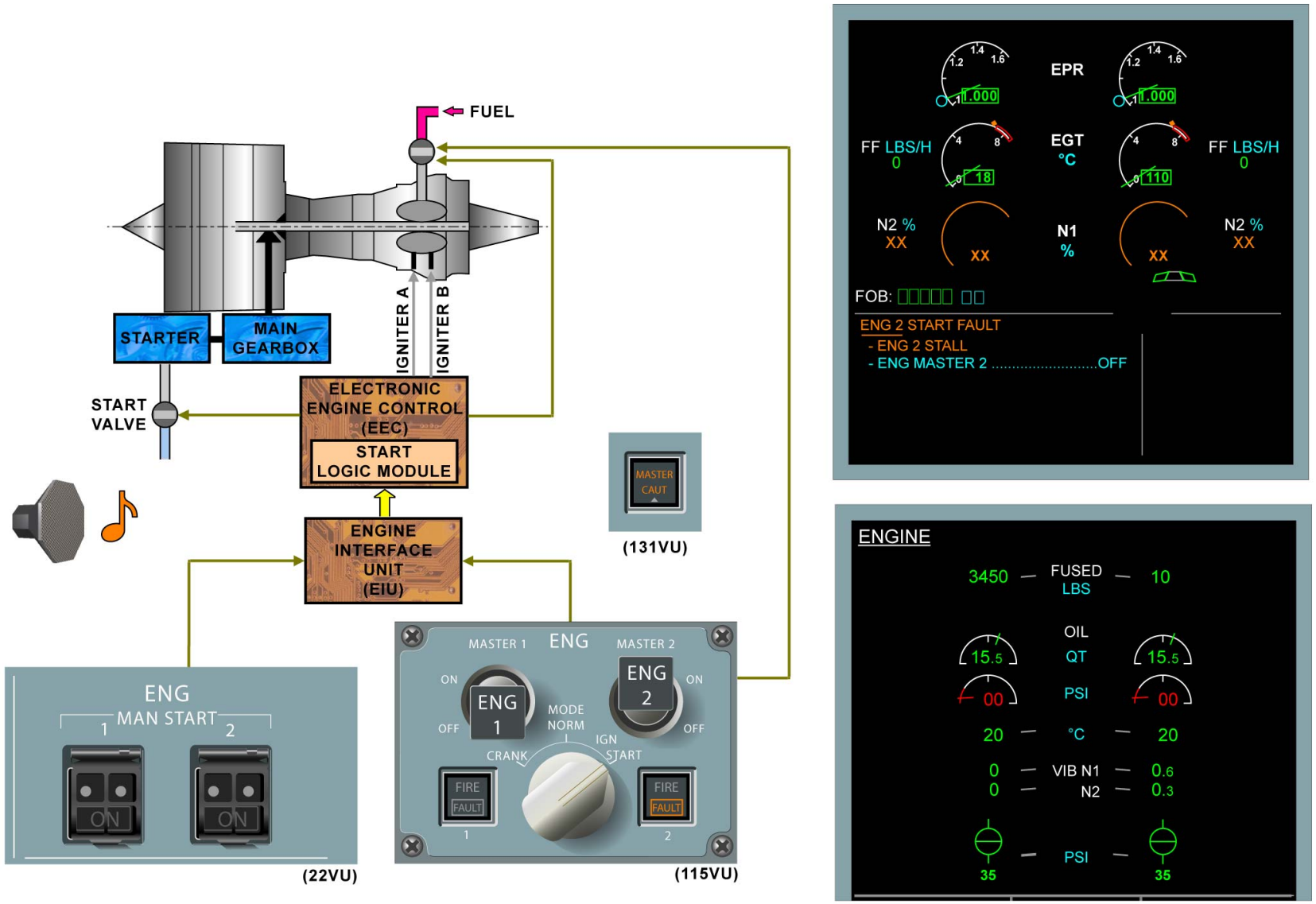
START FAULT (STALL AUTOMATIC MODE)

In case of detected stall or Exhaust Gas Temperature (EGT) overlimit, the FADEC auto start control or the flight crew actions are identical.
When a stall or an EGT overlimit is detected, an aural warning sounds, the MASTER CAUT and the ENG FAULT light come on. An ECAM message appears. The FADEC shuts off the fuel and turn off ignition, then a dry crank phase is automatically performed.
After the auto cranking, the FADEC aborts the start sequence. Then the MASTER lever must be set to OFF.

UGB13131 - U7ST0M0 - UM74D2IAE000004



START FAULT (STALL AUTOMATIC MODE)



START FAULT (STALL AUTOMATIC MODE)

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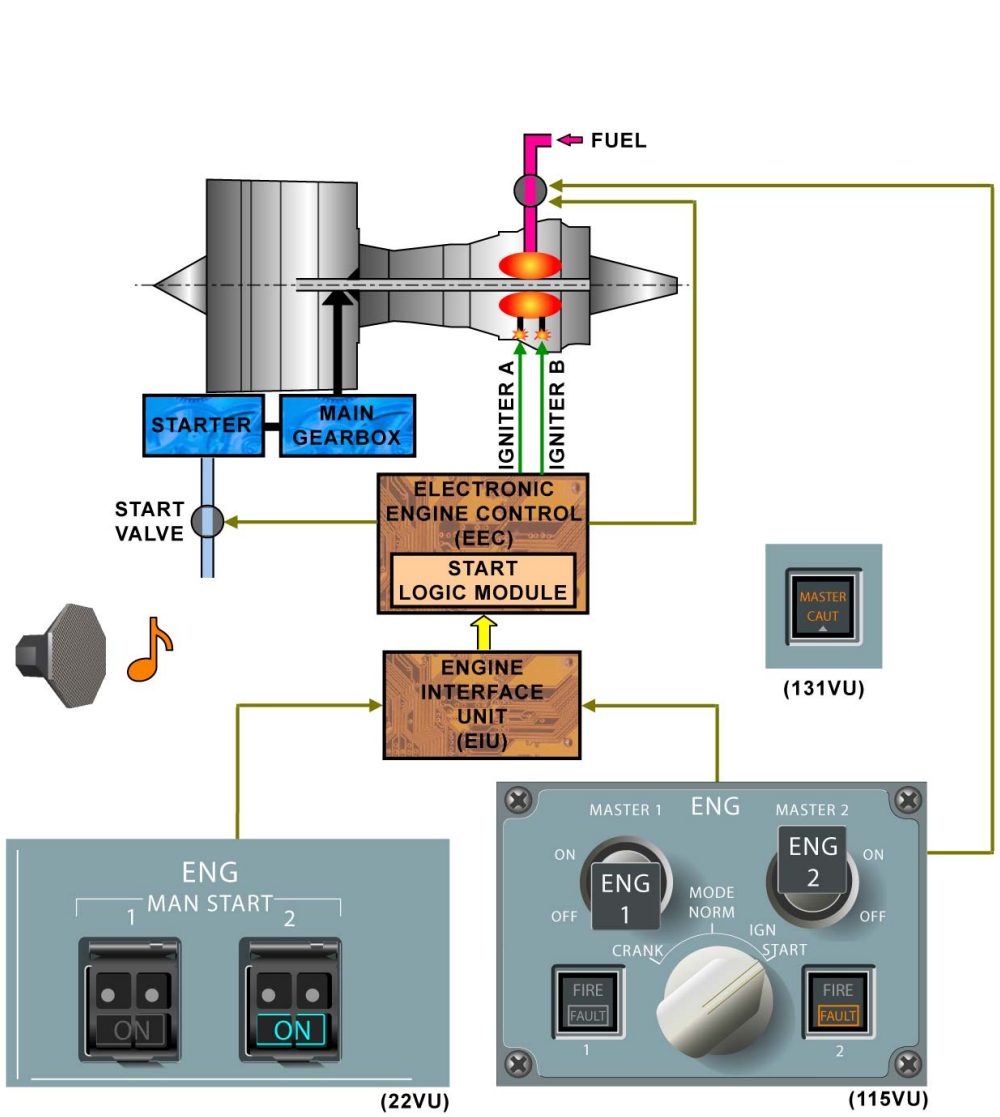
UGB13131 - U7ST0M0 - UM74D2IAE000004

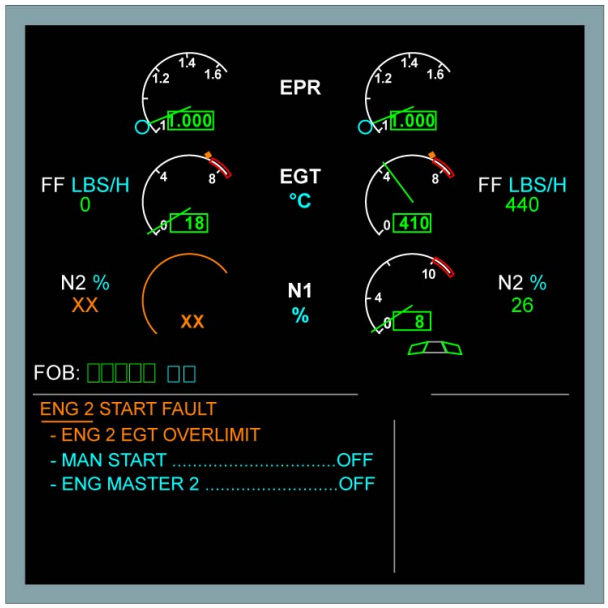
START FAILURES (US) (3)

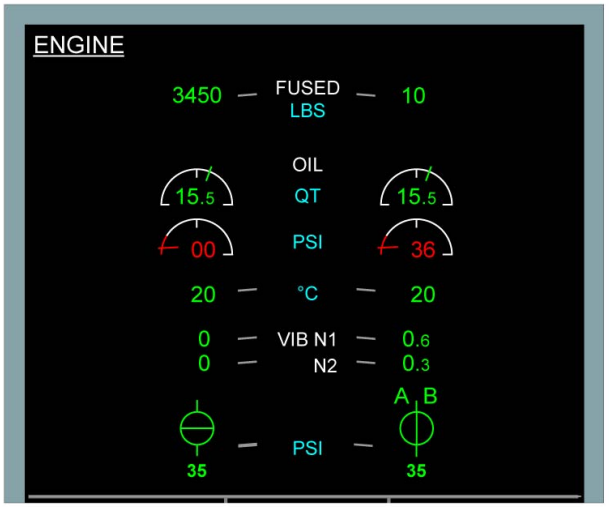
START FAULT (FAILURE DURING ENG MANUAL START MODE)

During the start, in case of EGT exceedance, an aural warning is triggered. The MASTER CAUT and the ENG FAULT lights come on. An ECAM message comes into view. In manual start, the FADEC does not abort the start.
The Crew operates the MASTER LEVER switch to OFF to stop the engine, as per ECAM procedure.

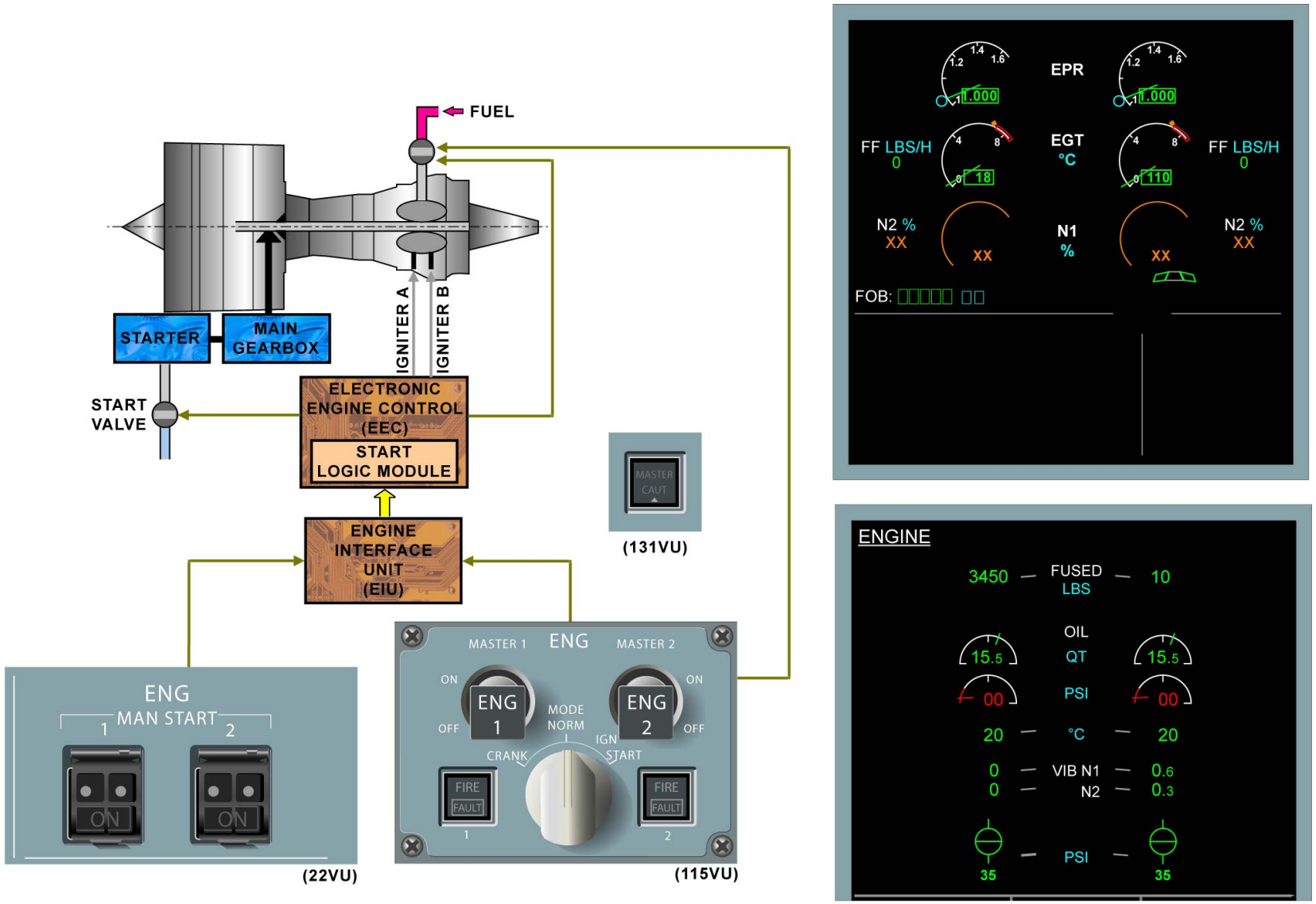
UGB13131 - U7ST0M0 - UM74D2IAE000004







START FAULT (FAILURE DURING ENG MANUAL START MODE)



START FAULT (FAILURE DURING ENG MANUAL START MODE)

EWD: FAILURE TITLE CONDITIONS	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNINGS
START VALVE (NOT OPEN)	SINGLE CHIME	MASTER CAUT	ENG	ENG FAULT LT
START VALVE (NOT CLOSED)				
START FAULT (IGNITION AUTOMATIC MODE)				
START FAULT (IGNITION MANUAL MODE)				
START FAULT (STALL AUTOMATIC MODE)				
START FAULT (EGT OVERLIMIT MANUAL MODE)				

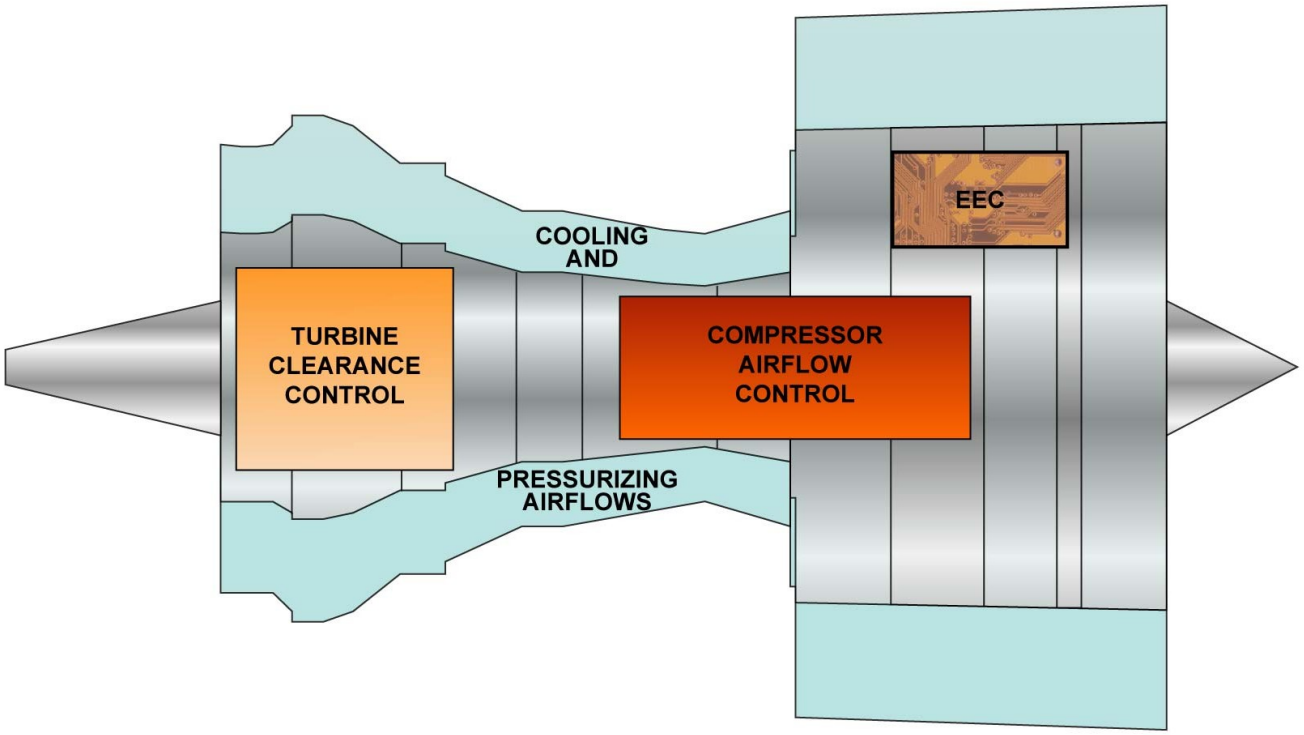
START FAULT (FAILURE DURING ENG MANUAL START MODE)

UGB13131 - U7ST0M0 - UM74D2IAE000004

AIR SYSTEM DESCRIPTION/OPERATION (3)

GENERAL

The engine air system makes sure that the compressor airflow and turbine clearances are controlled. The system also deals with the cooling and pressurizing airflows.


EEC
COOLING
AND
TURBINE
CLEARANCE
CONTROL
COMPRESSOR
AIRFLOW
CONTROL
PRESSURIZING
AIRFLOWS

GENERAL

AIR SYSTEM DESCRIPTION/OPERATION (3)

COMPRESSOR AIRFLOW CONTROL

The compressor airflow control is fulfilled by a booster stage bleed valve system, a Variable Stator Vane (VSV) system and additional bleed valves at the 7th and 10th stages of the High-Pressure Compressor (HPC). All these systems are controlled by the Electronic Engine Control (EEC). The booster stage bleed valve system is used for the booster compressor airflow discharge into the fan air stream to make sure that the booster compressor output matches the HPC requirements at low engine speed and deceleration. The VSV system directs the airflow into the HPC 4 initial stages to prevent blade stall and engine surge. Four bleed valves, three for the 7th stage and one for the 10th stage of the HPC, complete the compressor airflow control.

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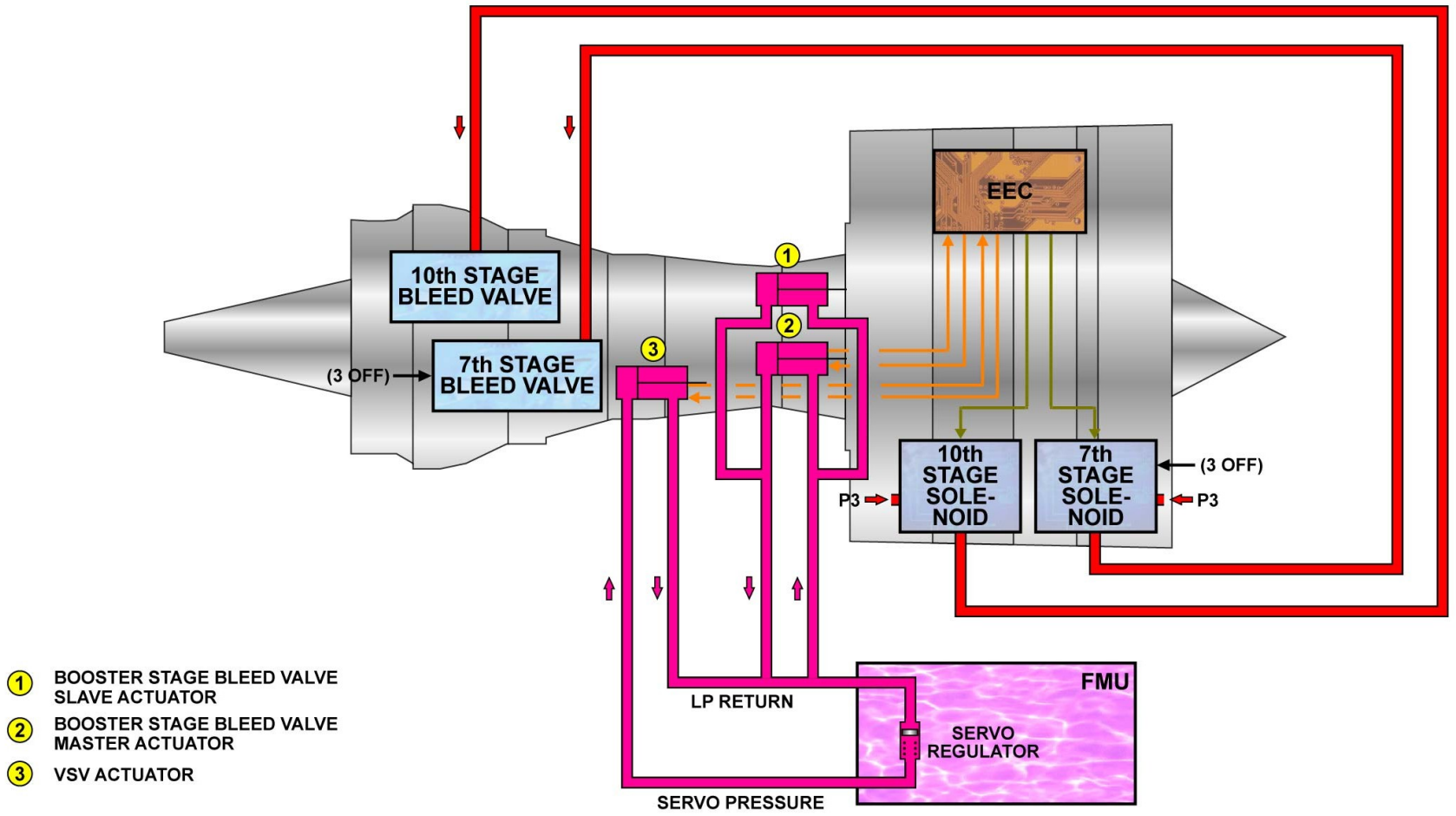
FMU: FUEL METERING UNIT



COMPRESSOR AIRFLOW CONTROL

AIR SYSTEM DESCRIPTION/OPERATION (3)

COMPRESSOR AIRFLOW CONTROL (continued)

HANDLING BLEED VALVES

Handling bleed valves are installed onto the H.P. compressor to improve engine starting, and prevent engine surge when the compressor is operating at off-design conditions.

A total of four bleed valves are used, three on stage 7 and one on stage 10.

The handling bleed valves are 'two position' only - fully open or fully closed, and are operated pneumatically by their respective solenoid control valve. The solenoid control valves are scheduled by the EEC.

When the bleed valves are open, H.P. compressor air bleeds into the fan duct through ports in the inner barrel of the 'C' ducts.

The servo air used to operate the bleed valves is H.P. compressor delivery air.

The bleed valves are arranged radially around the H.P. compressor case. Silencers are used on some bleed valves.

All the bleed valves are spring loaded to the open position and as a result will always be in the correct position (open) for starting.

The bleed valves and the solenoid control valves operate in the same manner. The bleed valve is a two-position valve and is either fully open or fully closed. The bleed valve is spring loaded to the open position and so all the bleed valves will be in the correct open position for engine start.

When the engine is started the bleed air will try to close the valve. The valve is kept in the open position by servo air (P3) supplied from the solenoid control valve, (solenoid de-energized) as shown below.

The EEC will close the bleed valves at the correct time during acceleration. The bleed valve is closed by the EEC, which energizes the solenoid control valve, as shown below.

Energizing the solenoid control valve vents the P3 servo air from the opening chamber of the bleed valve, and the valve will move to the closed position.

During an engine deceleration the reverse operation occurs and the bleed valve opens.

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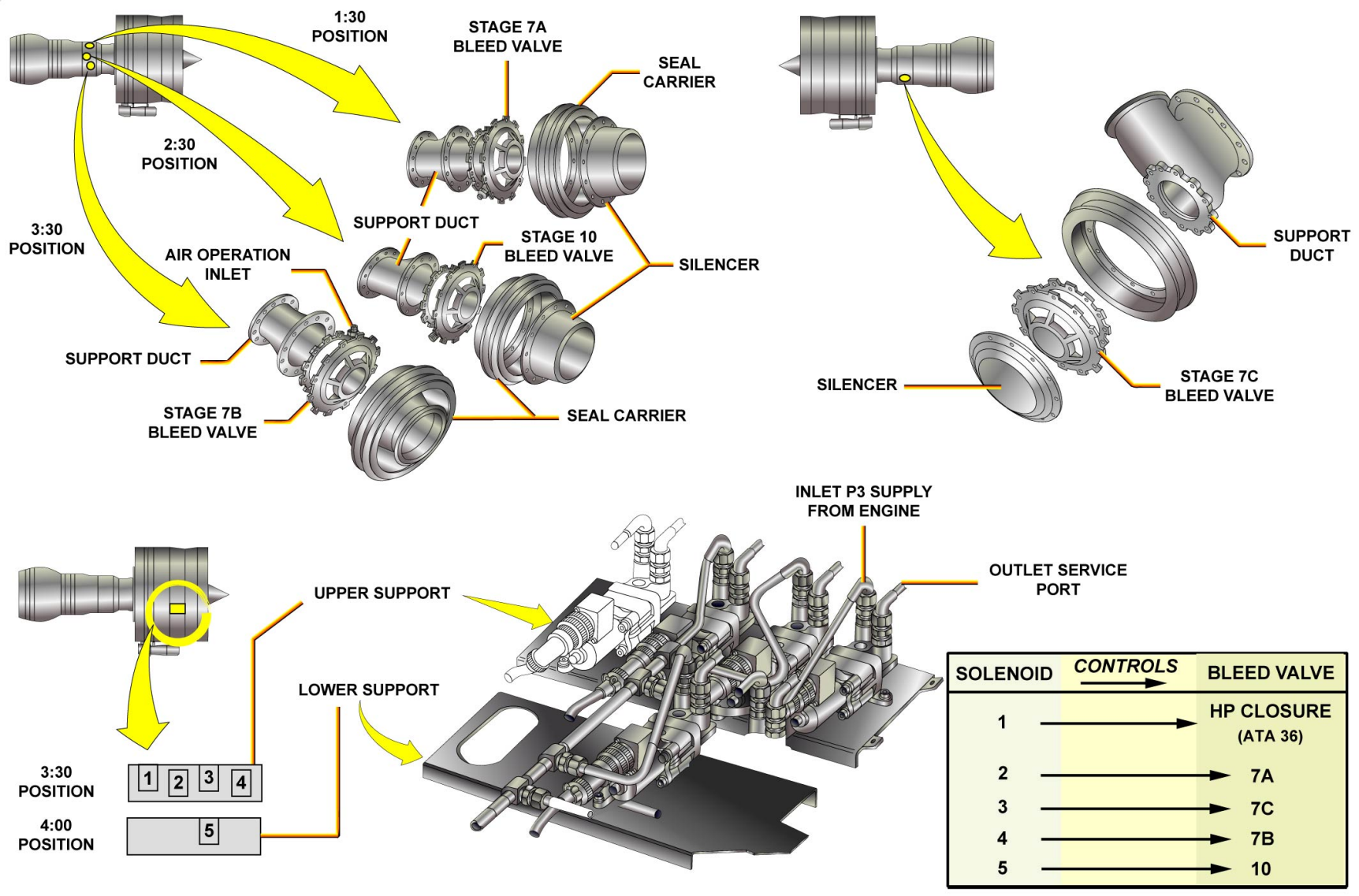
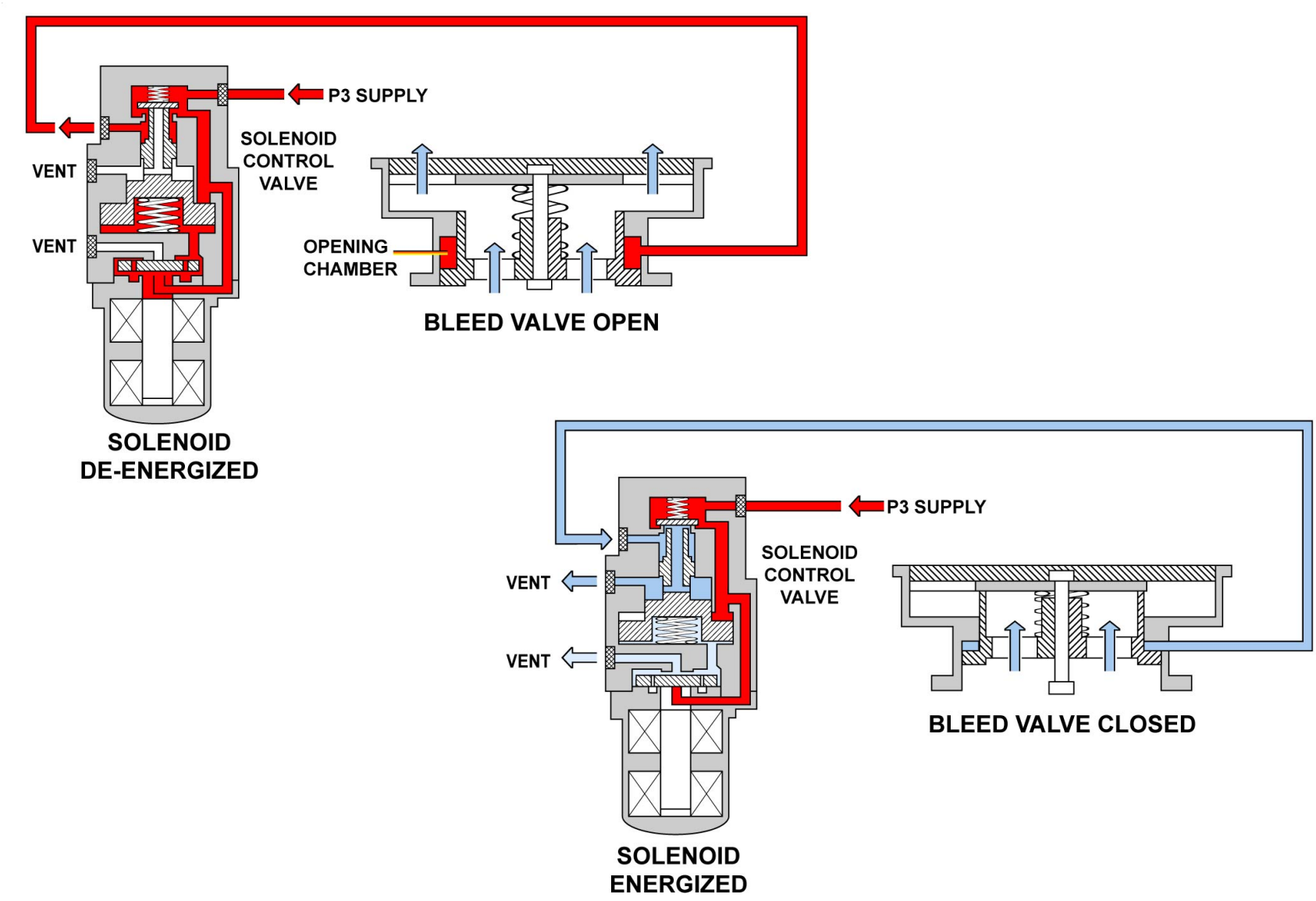


COMPRESSOR AIRFLOW CONTROL - HANDLING BLEED VALVES



COMPRESSOR AIRFLOW CONTROL - HANDLING BLEED VALVES

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AIR SYSTEM DESCRIPTION/OPERATION (3)

COMPRESSOR AIRFLOW CONTROL (continued)

BOOSTER STAGE BLEED VALVE FUNCTION

The Booster Stage Bleed Valve (BSBV) System discharges air from the Low Pressure compressor at engine station 2.5 into the fan air duct.

The BSBV gives improved surge margin during engine start and transient operation. The bleed valve is controlled by the EEC and is fully modulating, between the fully open and the fully closed positions. For starting the BSBV is fully open and will be progressively close during engine acceleration, while during cruise and take off the valve is fully closed. For deceleration and engine operation in reverse thrust the valve is fully open. In the event of an engine surge the valve is opened to recover the airflow through the compressor.

The BSBV is a continuous ring valve that rotates and slides forward to open and rearwards to close. Ten support arms are driven via a lever and actuating rod by both BSBV actuators.

The two actuators use the high-pressure fuel from the FMU as a hydraulic medium.

The two BSBV actuators use pressurized fuel from the Fuel Metering Unit (FMU) as a hydraulic medium. The actuators are located on the rear of the intermediate casing on both sides of the High Pressure Compressor.

Only the left actuator interfaces with the EEC through a torque motor and is identified as the Master Actuator. The actuator on the right hand side is identified as the Slave Actuator. The two actuators are hydraulically linked to carry out a simultaneous operation.

The Master Actuator includes a LVDT, which transmits the actuator position and therefore the BSBV position to the EEC.

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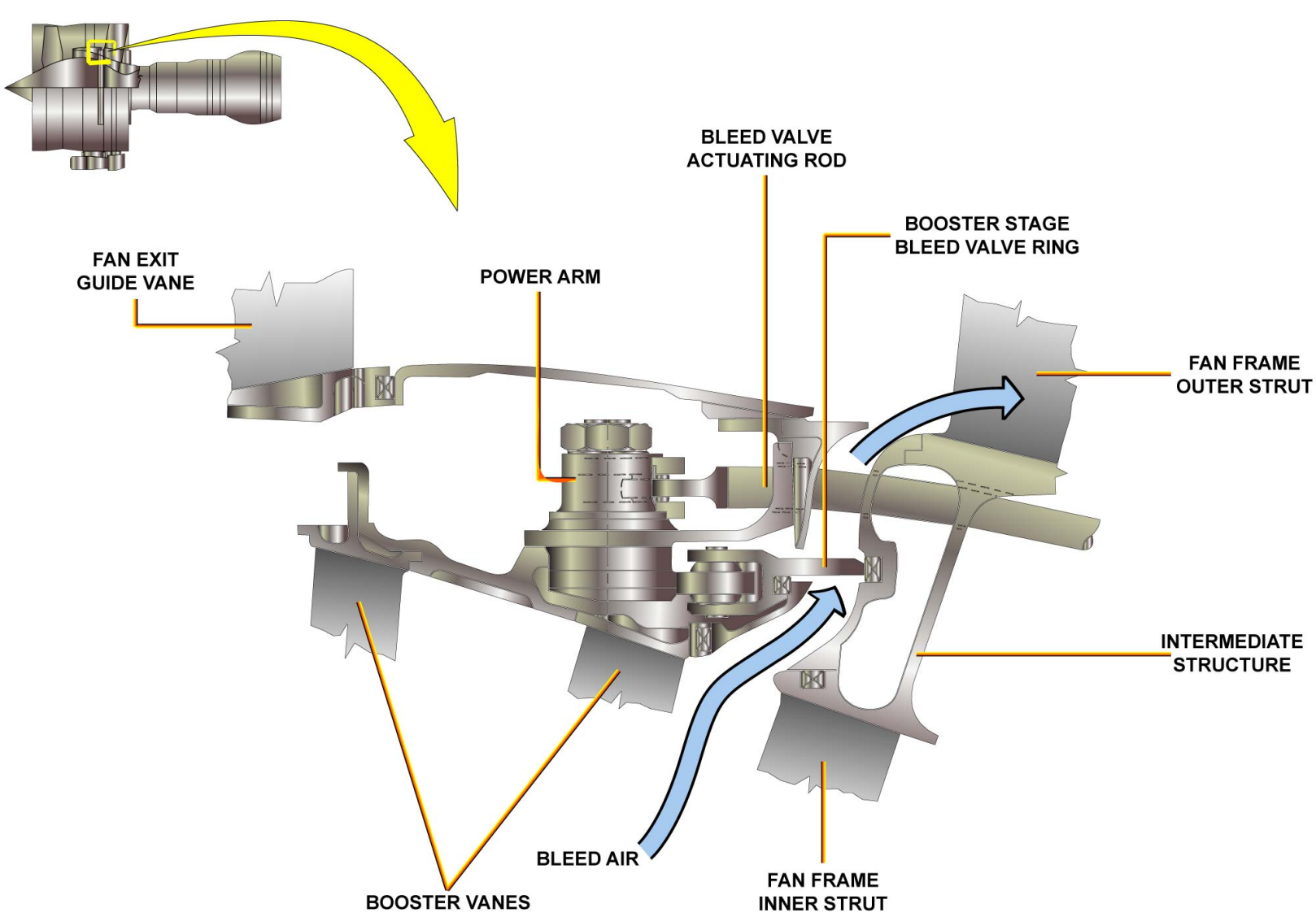
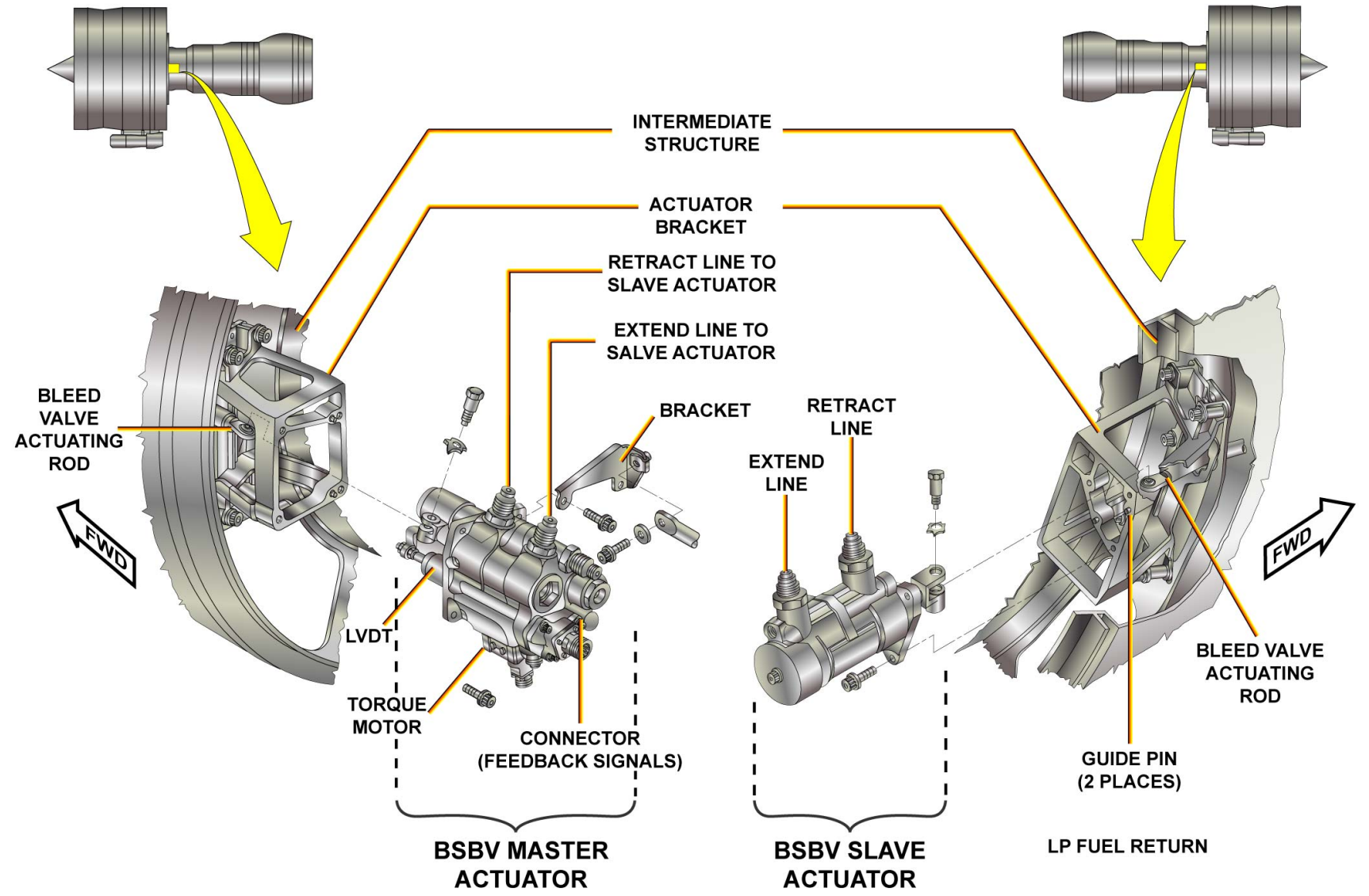


COMPRESSOR AIRFLOW CONTROL - BOOSTER STAGE BLEED VALVE FUNCTION



COMPRESSOR AIRFLOW CONTROL - BOOSTER STAGE BLEED VALVE FUNCTION

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UGB13131 - U7ST0M0 - UM75P11AE000002

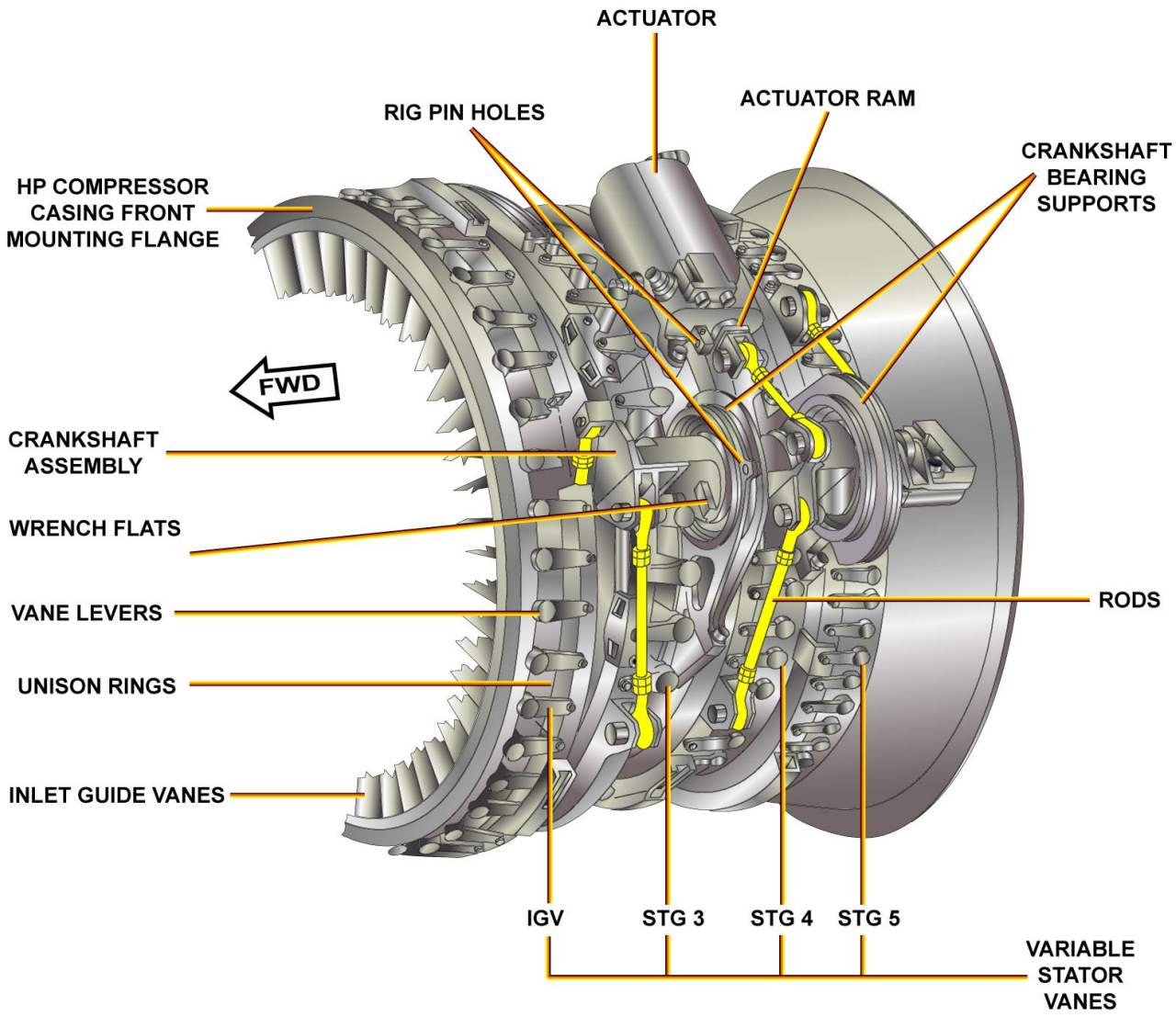
AIR SYSTEM DESCRIPTION/OPERATION (3)

COMPRESSOR AIRFLOW CONTROL (continued)

VSV SYSTEM

Variable Stator Vanes control the entry of air into the H.P. compressor.
The variable vanes control the angle at which the air enters the first three stages of the H.P. compressor.
The angle varies with the H.P. compressor speed (N2); this reduces the risk of blade stall and compressor surge.
The four stages of variable vanes comprises Inlet Guide Vanes (IGVs) in front of stage 3 and the Variable Stator Vanes (VSVs) behind the stages 3, 4, and 5.
Mechanical Arrangement
Each vane has pivots at its inner and outer ends, which allow the vane to rotate about its longitudinal axis.
The outer end of each vane is shaped into a shaft, which goes through the compressor case and is attached by a short lever to a 'unison ring', (one unison ring for each stage).
Short rods to a crankshaft connect the five unison rings. A short rod to an actuator that uses H.P. fuel as a hydraulic operating medium connects the crankshaft.
Signals from the EEC direct the H.P. fuel to extend/retract the actuator.
The actuator movement causes the crankshaft to rotate, and, through the unison rings, moves the variable stator vanes.
The actuator has an LVDT, which sends actuator positional information back to the EEC.

UGB13131 - U7ST0M0 - UM75P1IAE000002



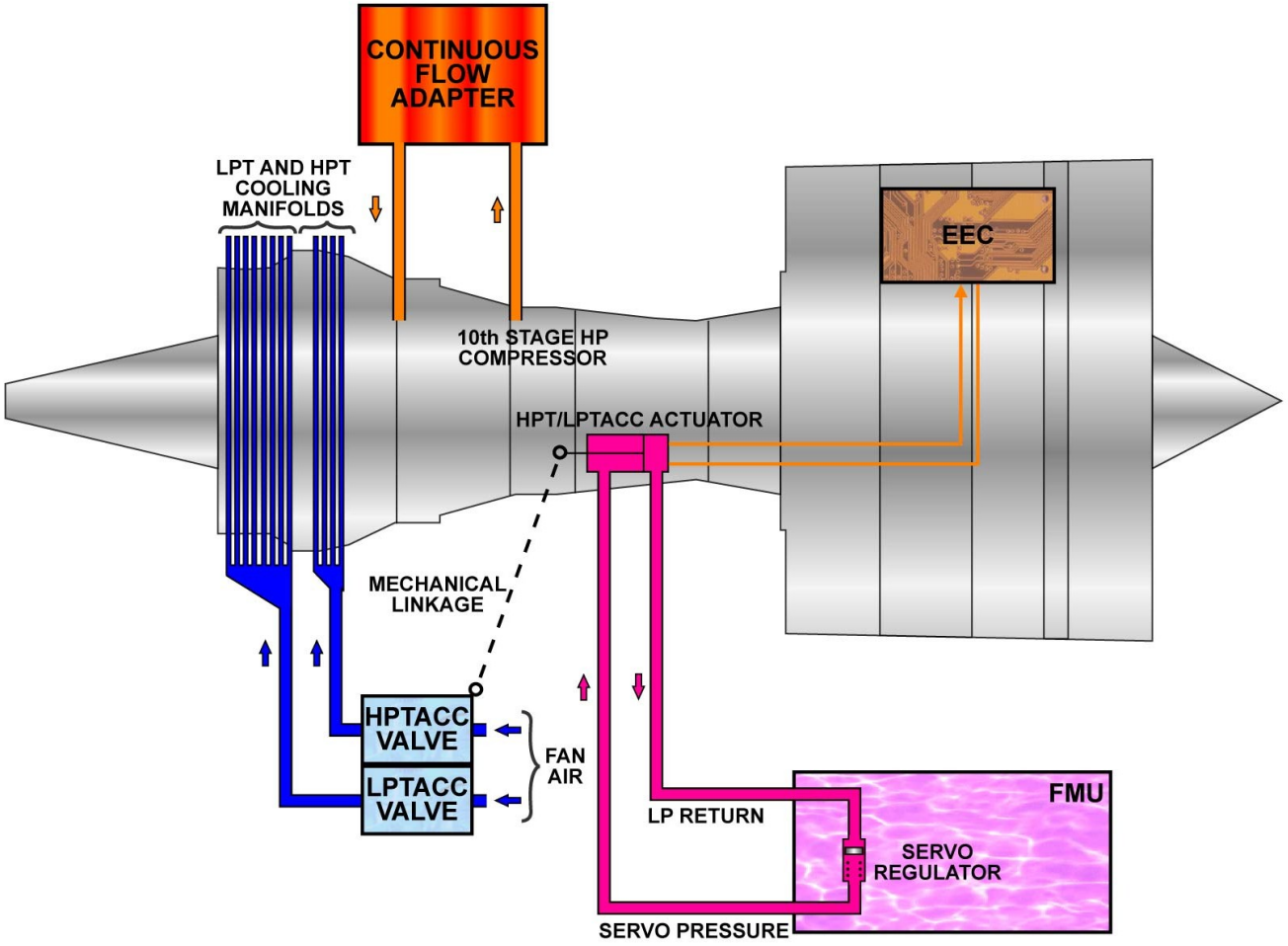
COMPRESSOR AIRFLOW CONTROL - VSV SYSTEM

AIR SYSTEM DESCRIPTION/OPERATION (3)

TURBINE CLEARANCE CONTROL AND TURBINE COOLING

The EEC controls the actuation of an Active Clearance Control (ACC) valve for the High Pressure (HP) and LP turbine active clearance control. The ACC system fulfills the blade tip clearances of the turbines for better performance. The EEC controls a dual ACC valve, which discharges fan air through manifolds to cool the surfaces of the HP and LP turbine cases during climb and cruise power operations. The continuous flow adapter supplies supplemental air, from the HPC 10^{th} stage, to cool the stage 2 blades and HP 1 turbine disc bore.

FMU: FUEL METERING UNIT
HPT: HIGH PRESSURE TURBINE
HPTACC: HIGH PRESSURE TURBINE ACTIVE CLEARANCE CONTROL
LPT: LOW PRESSURE TURBINE
LPTACC: LOW PRESSURE TURBINE ACTIVE CLEARANCE CONTROL



TURBINE CLEARANCE CONTROL AND TURBINE COOLING

UGB13131 - U7ST0M0 - UM75P1IAE000002

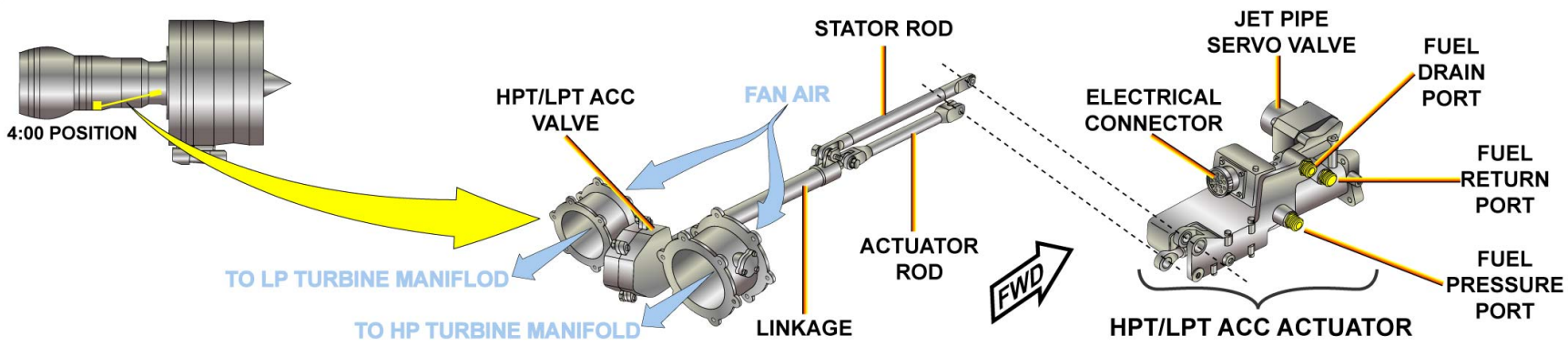
AIR SYSTEM DESCRIPTION/OPERATION (3)

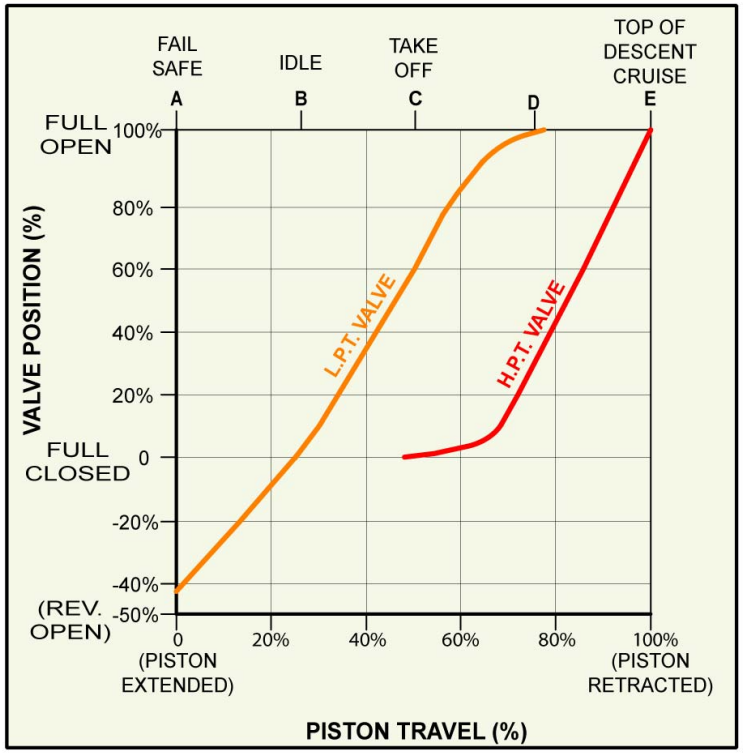
TURBINE CLEARANCE CONTROL AND TURBINE COOLING (continued)

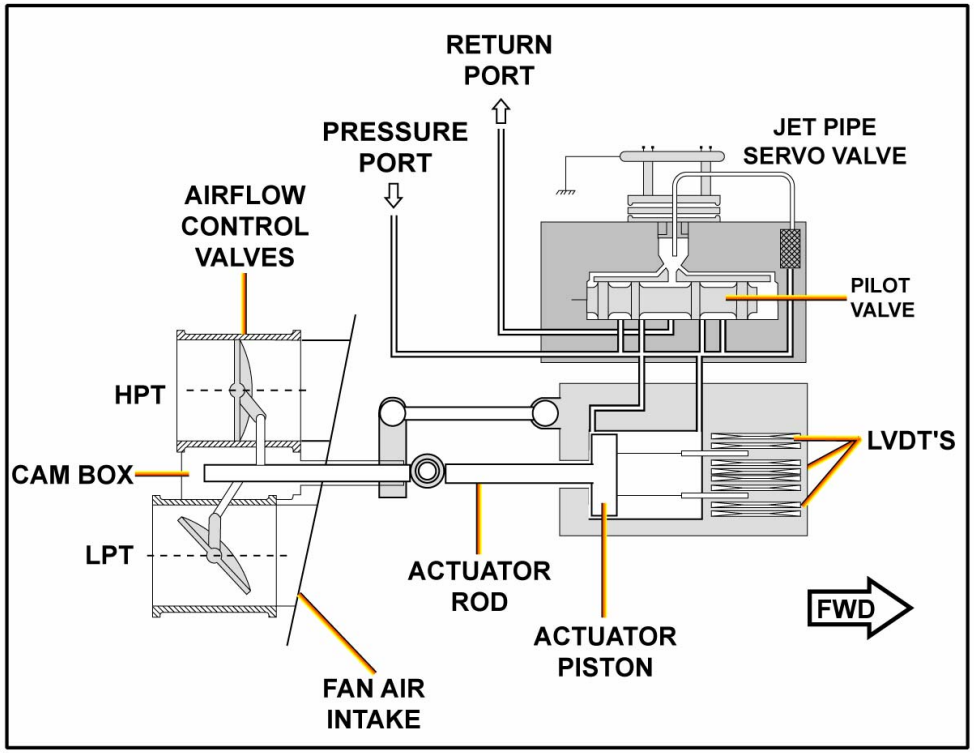
HP/LPTACC SYSTEM

The EEC controls the opening and closing of the ACC system by monitoring input signals of:
. Corrected N2
. Altitude
The EEC commands an input signal to the torque motor. The torque motor positions the jet pipe servo valve.
The torque motor can deflect the jet pipe servo valve to bias the direction of flow of the servo fuel pressure.
The jet pipe servo valve controls the direction of flow of servo fuel pressure to effectively move the pilot valve.
The pilot valve moves and gets servo fuel pressure to either side of the piston. Servo fuel pressure will act on one side of the piston at any one time when a movement is required.
The movement of the piston moves a push pull rod that in turn operates the modulating air control valve.
When stabilisation of the piston is required the EEC will cancel the input signal to the torque motor.
This allows the jet pipe to return to the central position and as a result of this the pilot valve will move into the balanced position.
Servo fuel pressure is now present on both sides of the pilot valve.
The spring will bias the pilot valve position by forcing it to one side.
The dual track LVDTs will send feedback signals to the EEC of the ACC system operation.

UGB13131 - U7ST0M0 - UM75P1IAE000002







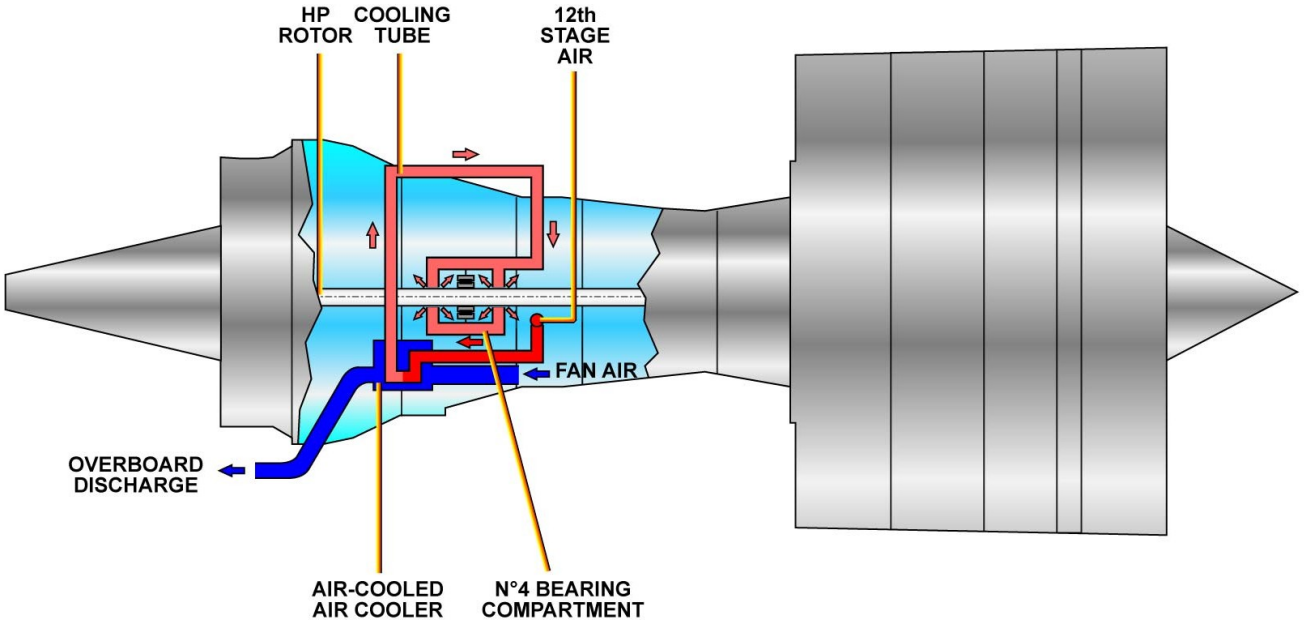
TURBINE CLEARANCE CONTROL AND TURBINE COOLING - HP/LPTACC SYSTEM

UGB13131 - U7ST0M0 - UM75P11AE000002

AIR SYSTEM DESCRIPTION/OPERATION (3)

N°4 BEARING COMPARTMENT COOLING

The number 4 bearing compartment is cooled by 12th stage air of the HPC. An external line carries this air through an air-cooled air cooler before entering into the Nº4 bearing compartment. The air-cooled air cooler cools the 12th stage air of the HPC with fan air before going into the Nº4 bearing compartment. The fan air is then discharged overboard.



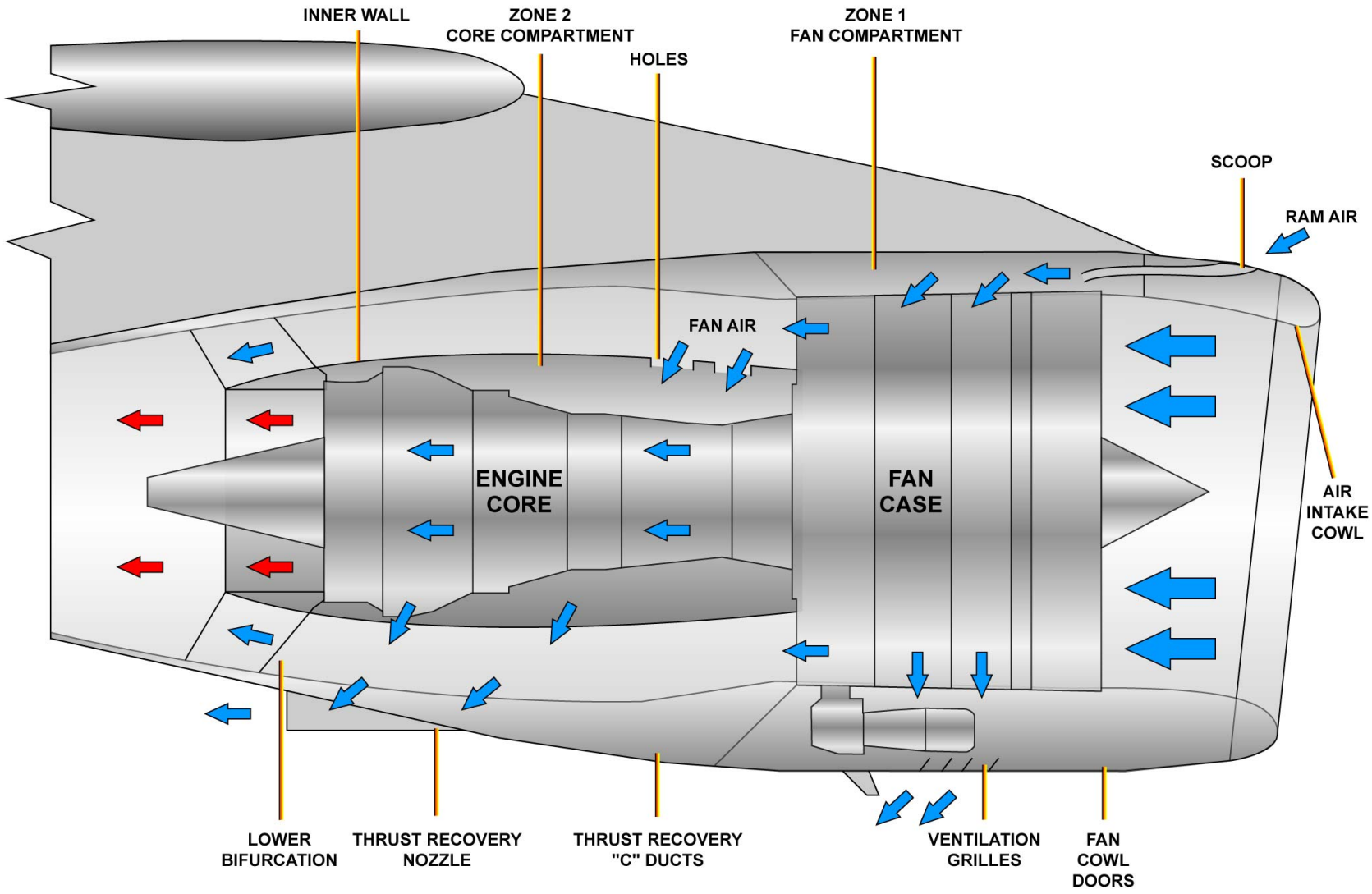
N°4 BEARING COMPARTMENT COOLING

AIR SYSTEM DESCRIPTION/OPERATION (3)

FAN AND CORE VENTILATION ZONES

The fan case and engine core compartments, which make the nacelle, are ventilated to supply airflow around the engine during its operation.
Zone 1: the fan case and accessories are cooled by air taken in by a scoop on the upper side of the air intake cowl. The air is then vented overboard through two ventilation grilles at the bottom of each fan cowl door.
Zone 2: core compartment ventilation is supplied by fan air through holes in the inner wall of the thrust reverser "C" ducts. The air circulates into the core compartment and flows through the lower bifurcation of the thrust reverser "C" ducts, then exits through the thrust recovery nozzle.

UGB13131 - U7ST0M0 - UM75P11AE000002



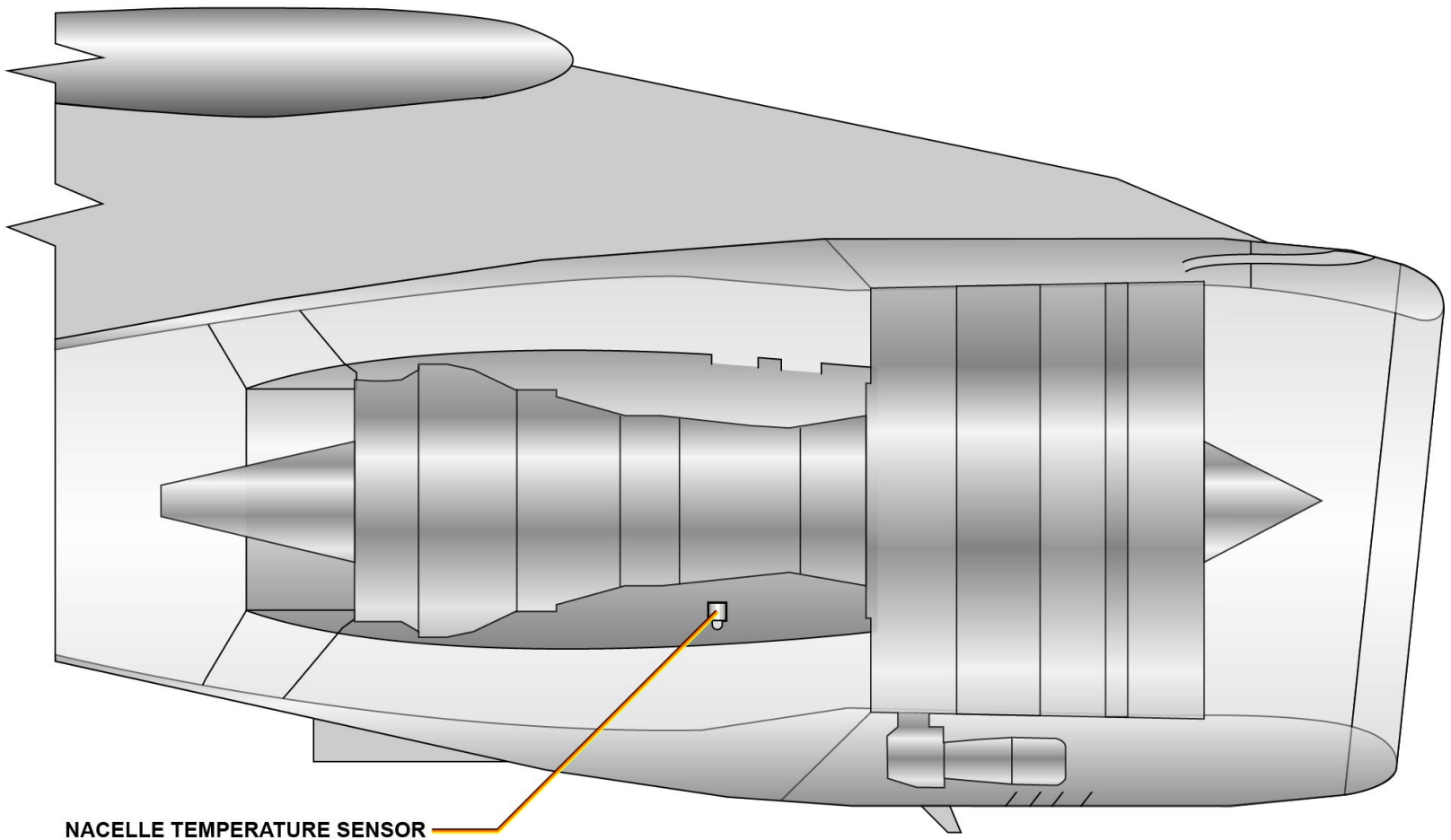
FAN AND CORE VENTILATION ZONES

AIR SYSTEM DESCRIPTION/OPERATION (3)

NACELLE TEMPERATURE

The nacelle temperature is monitored by a temperature probe installed in the ventilated core compartment. The nacelle temperature sensor gives indication to the ECAM lower display.

UGB13131 - U7ST0M0 - UM75P11AE000002



NACELLE TEMPERATURE

ENGINE THRUST MANAGEMENT (3)

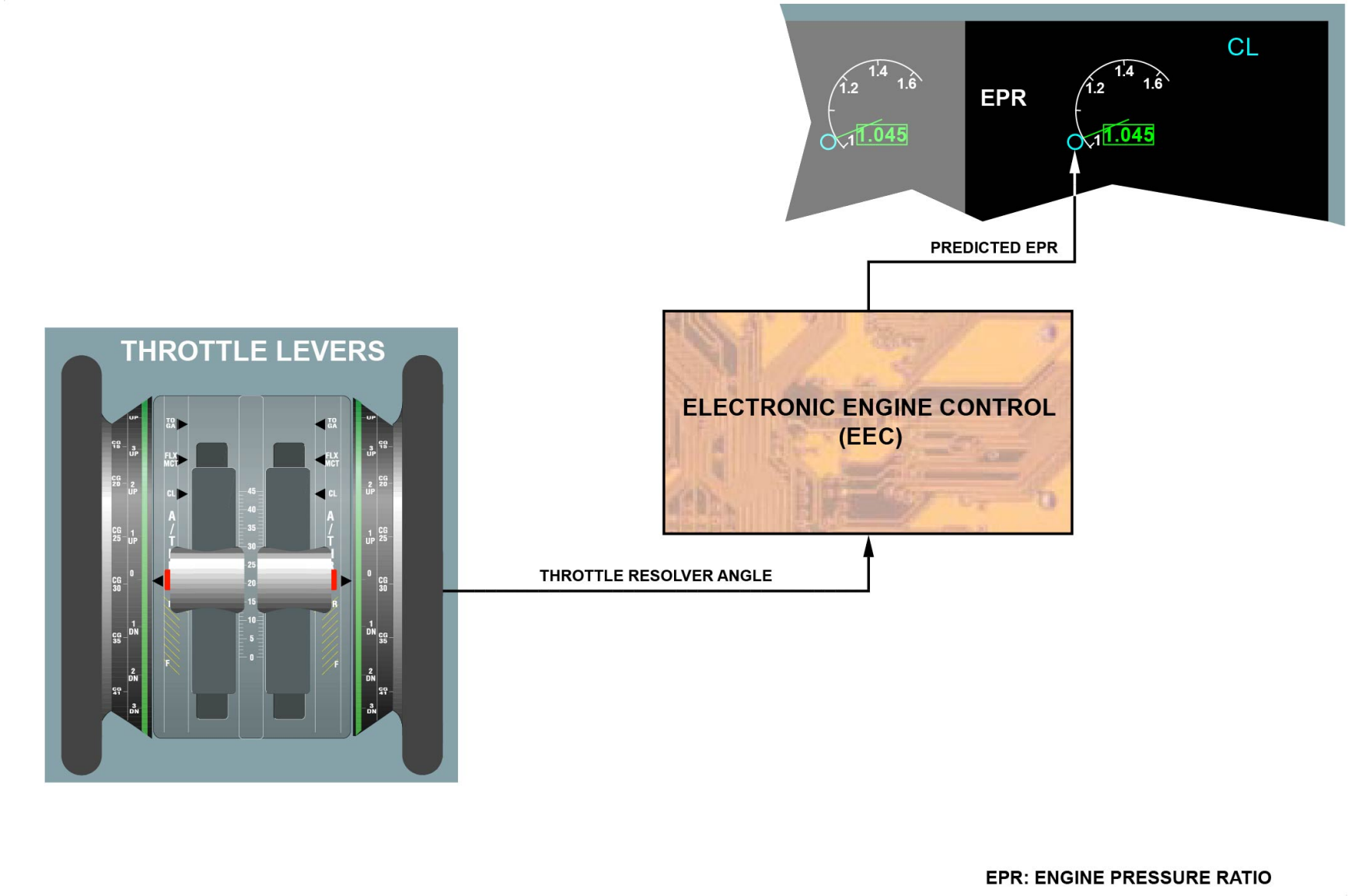
BASIC INFORMATION

Some basic information about engine thrust management is shown in this module.

PREDICTED EPR

The predicted Engine Pressure Ratio (EPR) is indicated by a cyan circle on the EPR indicator and corresponds to the value determined by the Throttle Resolver Angle (TRA).

UGB13131 - U7ST0M0 - UM76D11AE000002



BASIC INFORMATION - PREDICTED EPR

ENGINE THRUST MANAGEMENT (3)

BASIC INFORMATION (continued)

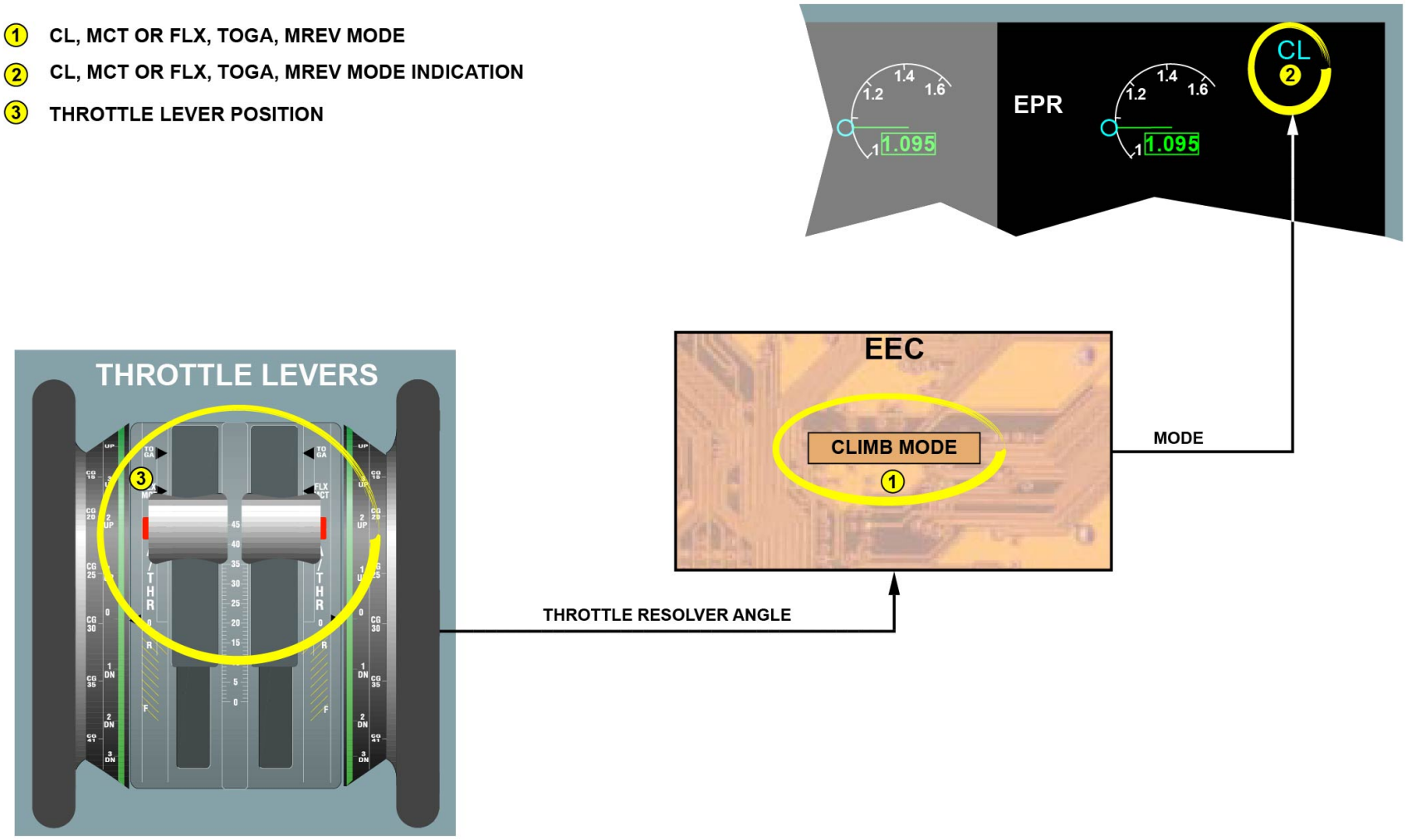
THRUST LIMIT MODES

The throttle levers are used as thrust limit mode selectors. Depending on the throttle lever position, a thrust limit mode is selected and appears on the upper ECAM display. If the throttle levers are set between two detent points, the upper detent will determine the thrust limit mode. The thrust limit modes are:

- CL: Climb,
- FLX: Flexible take-off,
- MCT: Maximum Continuous Thrust,
- TOGA: Take Off/Go Around.
- MREV: Maximum Reverser

UGB13131 - U7ST0M0 - UM76D11AE000002

1. CL, MCT OR FLX, TOGA, MREV MODE
2. CL, MCT OR FLX, TOGA, MREV MODE INDICATION
3. THROTTLE LEVER POSITION



EEC: ELECTRONIC ENGINE CONTROL

BASIC INFORMATION - THRUST LIMIT MODES

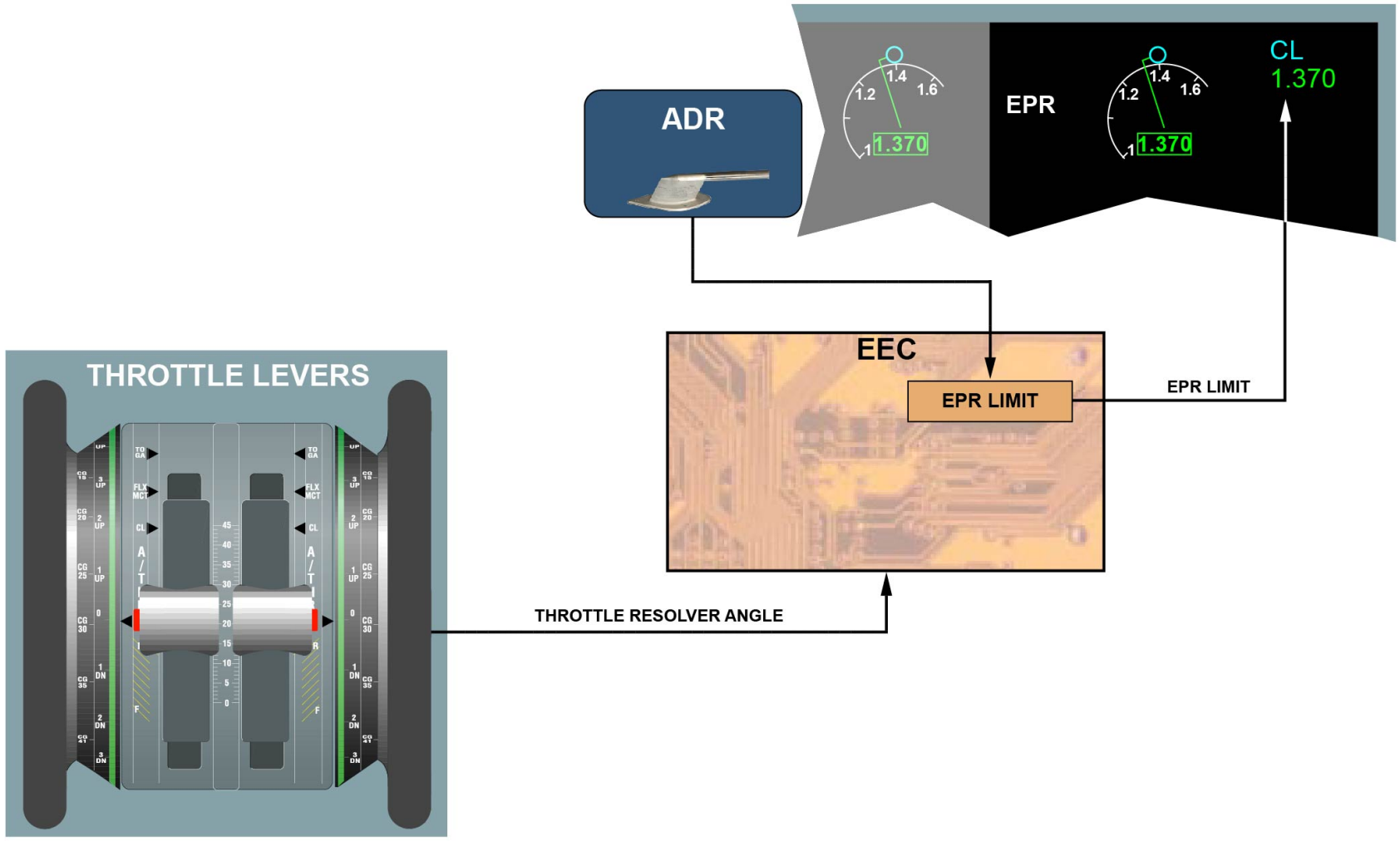
ENGINE THRUST MANAGEMENT (3)

BASIC INFORMATION (continued)

EPR LIMIT

For each thrust limit mode selection, an EPR limit is computed according to the Air Data Reference (ADR) and appears on the upper ECAM display beside the thrust limit mode indication.

UGB13131 - U7ST0M0 - UM76D11AE000002



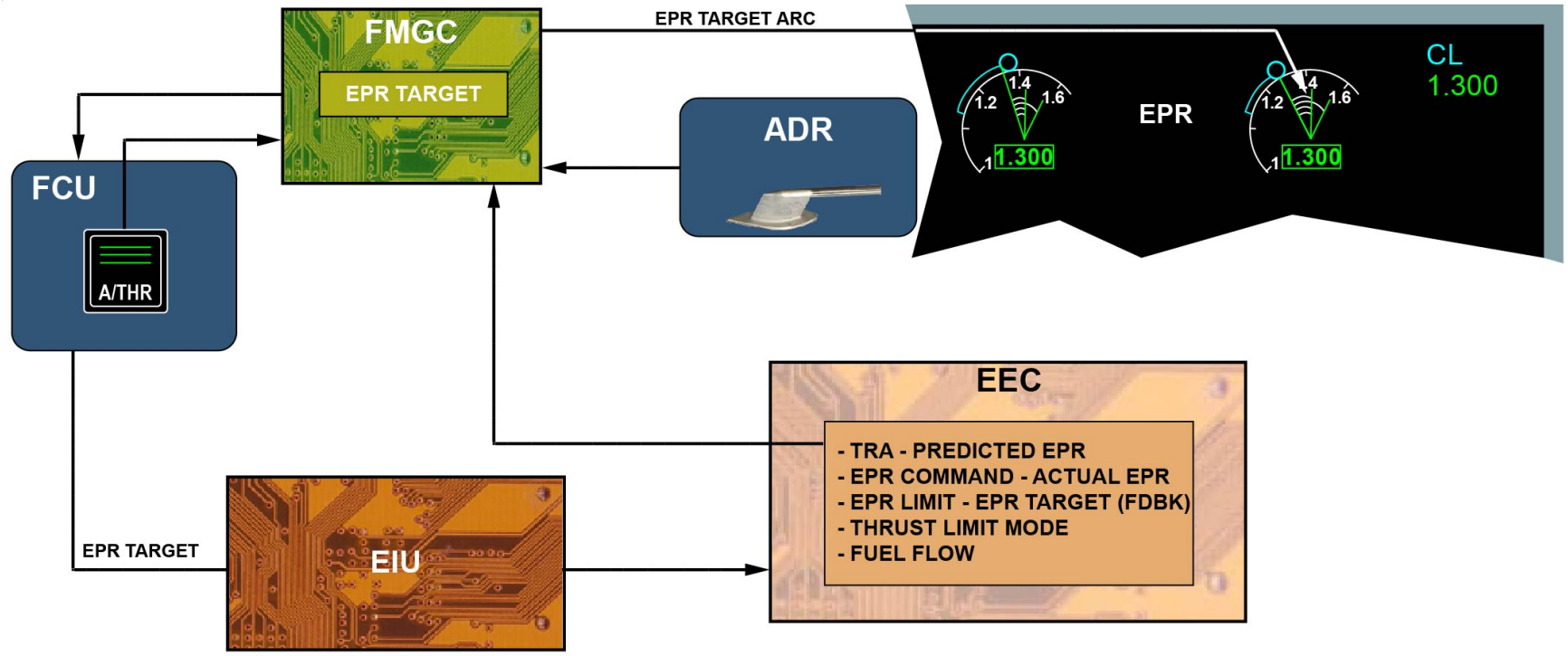
BASIC INFORMATION - EPR LIMIT

ENGINE THRUST MANAGEMENT (3)

BASIC INFORMATION (continued)

EPR TARGET

For its auto thrust function, the Flight Management and Guidance System (FMGS) computes an EPR target according to ADR and engine parameters and sends it to the Electronic Engine Control (EEC).



ADR: AIR DATA REFERENCE
EEC: ELECTRONIC ENGINE CONTROL
EPR: ENGINE PRESSURE RATIO
FCU: FLIGHT CONTROL UNIT
FMGC: FLIGHT MANAGEMENT AND GUIDANCE COMPUTER

BASIC INFORMATION - EPR TARGET

ENGINE THRUST MANAGEMENT (3)

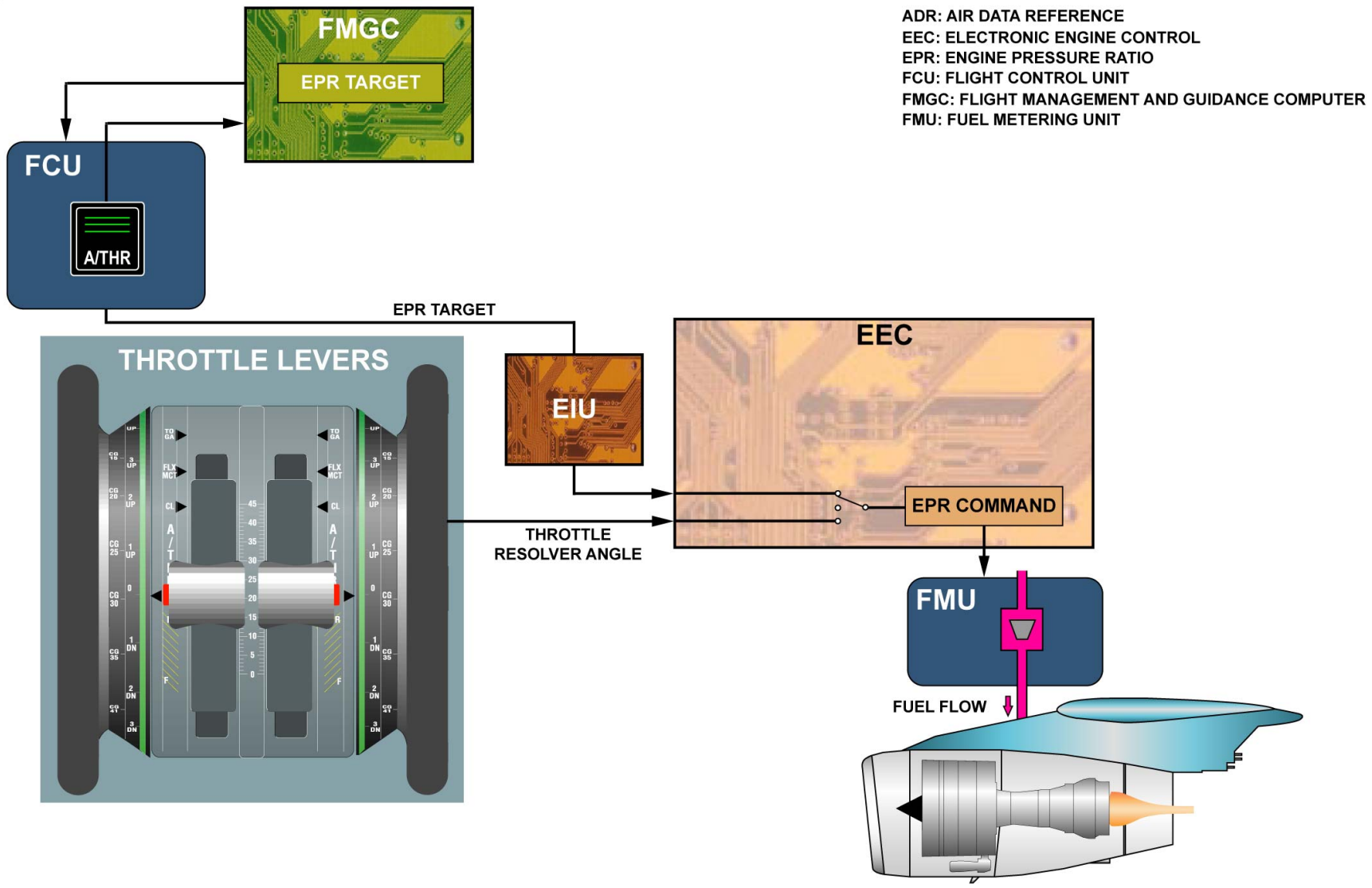
BASIC INFORMATION (continued)

EPR COMMAND

The EPR command, used to regulate the fuel flow, is the Flight Management and Guidance Computer (FMGC) EPR target when the auto thrust function is active. When the auto thrust function is not active, the EPR command is the EPR corresponding to the TRA. EPR command is either:

- EPR target,
- EPR corresponding to TRA.

UGB13131 - U7ST0M0 - UM76D11AE000002



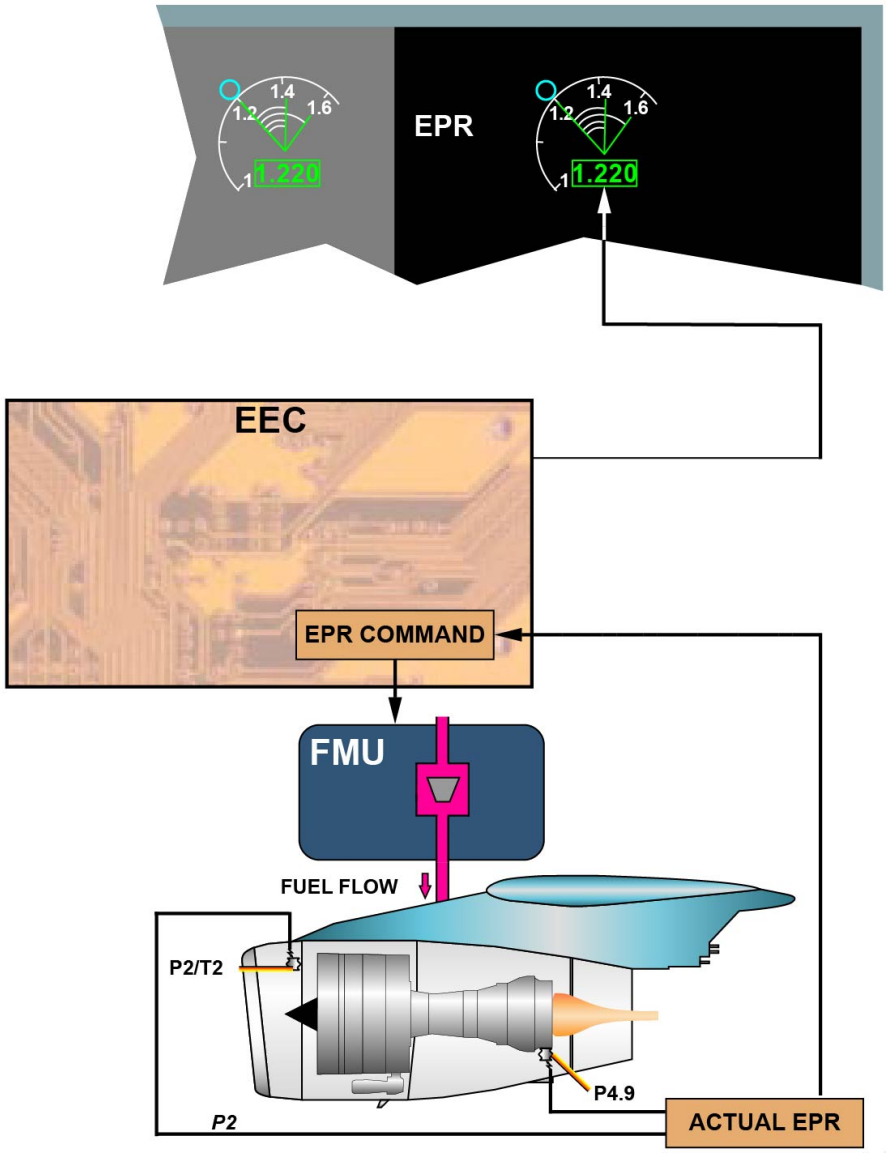
BASIC INFORMATION - EPR COMMAND

ENGINE THRUST MANAGEMENT (3)

BASIC INFORMATION (continued)

ACTUAL EPR

The actual EPR is the actual value given by the ratio of the LP turbine exhaust pressure (P4.9) to the engine inlet pressure (P2). The actual EPR is displayed in green on the EPR indicator. The actual EPR signal is also compared to the EPR command.



EEC: ELECTRONIC ENGINE CONTROL
EPR: ENGINE PRESSURE RATIO
FCU: FLIGHT CONTROL UNIT

BASIC INFORMATION - ACTUAL EPR

ENGINE THRUST MANAGEMENT (3)

AUTOTHRUST CONTROL MODE

The auto thrust function is engaged when the A/THR P/B is on. The auto thrust engages:
- when the A/THR P/B is pressed in,
- at take-off power application.

AUTOTHRUST ACTIVE

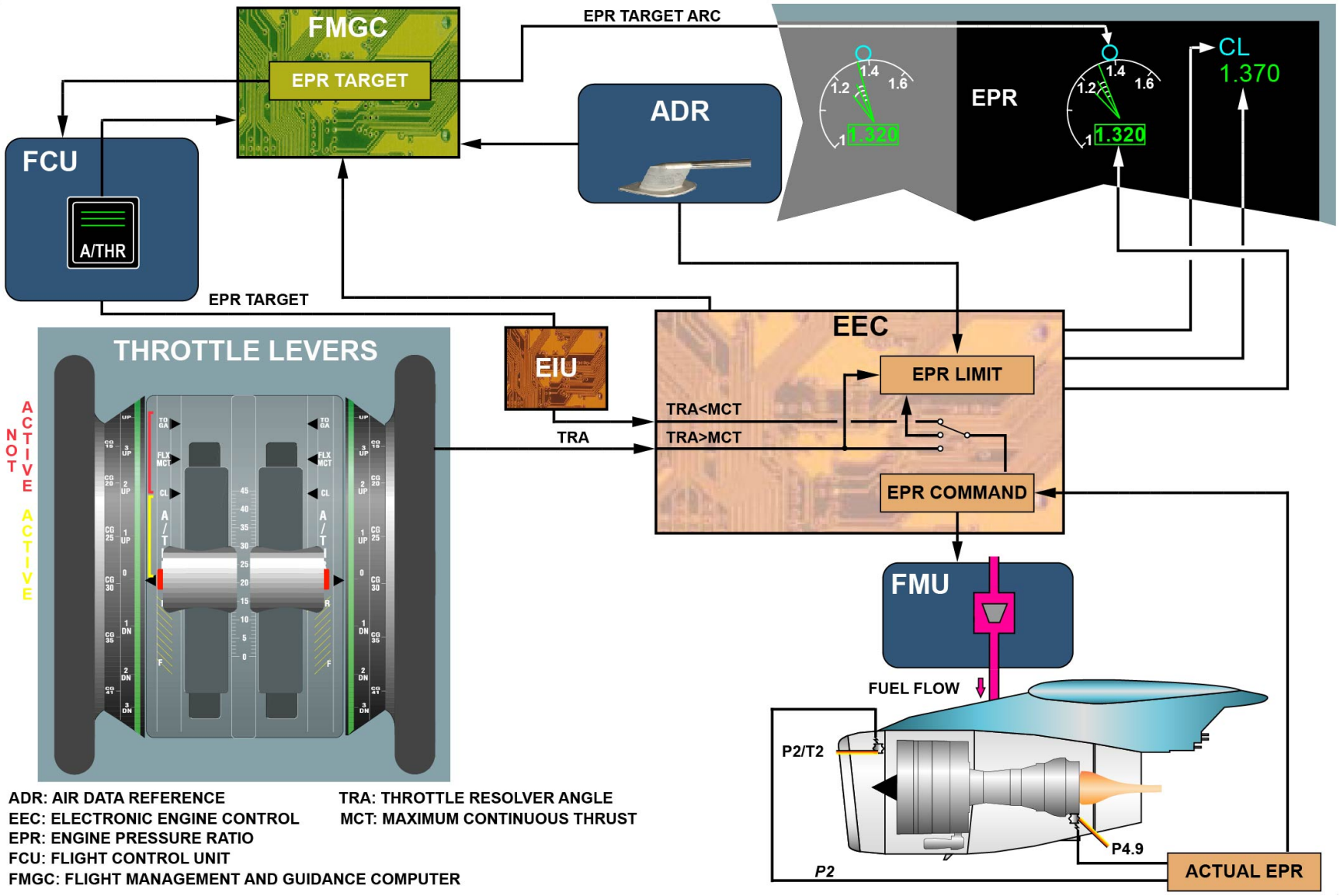
When engaged, the auto thrust function becomes active when the throttle levers are set to the Climb detent after take-off. The EPR command is the FMGC EPR target. The auto thrust function is active when the throttle levers are set between IDLE and CL, including CL, with 2 engines running.

NOTE: The auto thrust function active range is extended to MCT in the case of single engine operation.

When the throttle levers are set between two detent points, the EPR command is limited by the throttle lever position.

NOTE: In alpha floor condition the auto thrust function becomes active automatically. The EPR target is TOGA.

UGB13131 - U7ST0M0 - UM76D11AE000002



AUTOTHRUST CONTROL MODE - AUTOTHRUST ACTIVE

ENGINE THRUST MANAGEMENT (3)

AUTOTHRUST CONTROL MODE (continued)

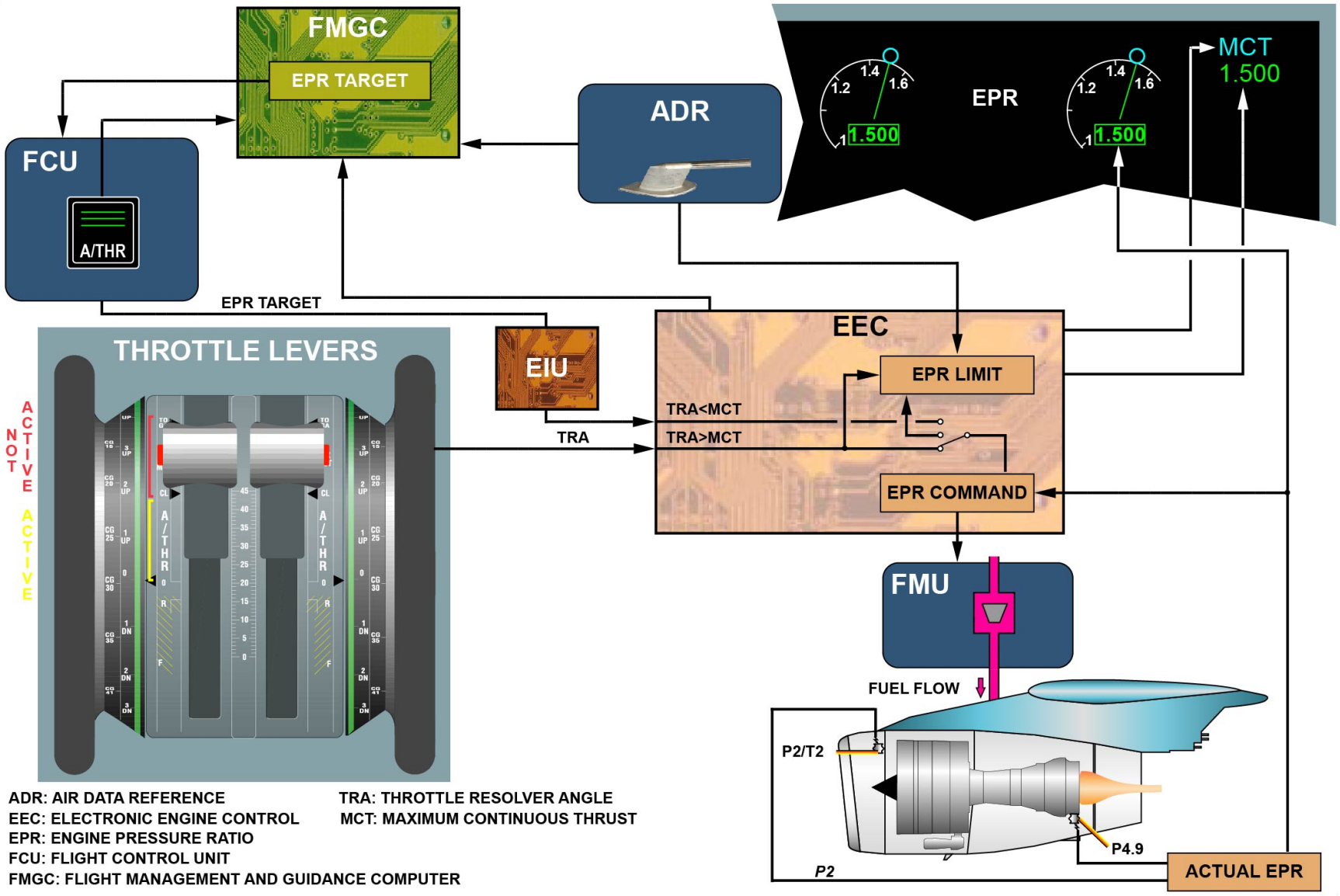
AUTOTHRUST NOT ACTIVE

When engaged, the auto thrust function becomes inactive when the throttle levers are set above CL with 2 engines running. The EPR command corresponds to the TRA.

NOTE: The auto thrust function is not active above MCT in case of single engine operation.

The auto thrust function is disengaged when the throttle levers are set at the IDLE stop.

UGB13131 - U7ST0M0 - UM76D11AE000002



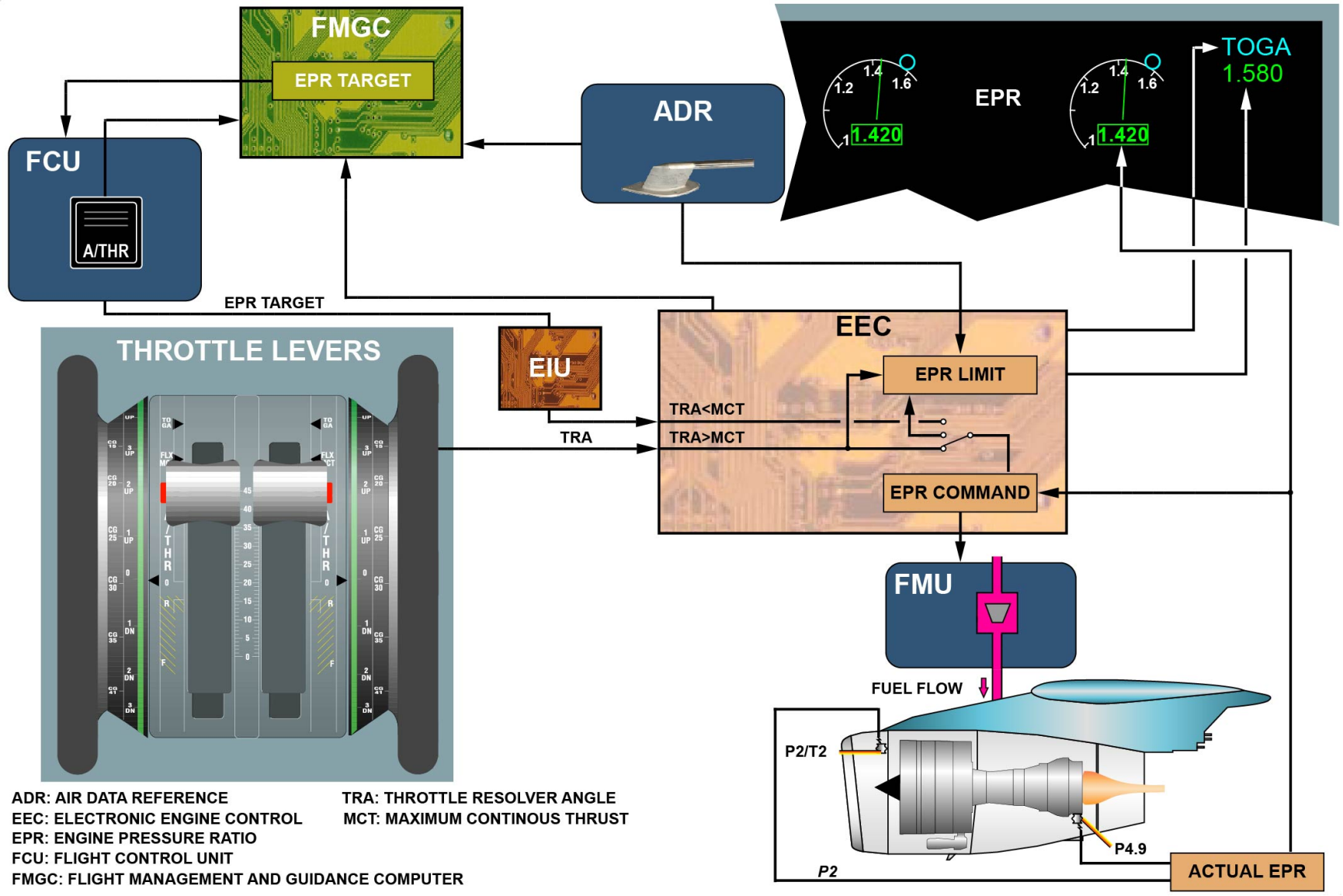
AUTOTHRUST CONTROL MODE - AUTOTHRUST NOT ACTIVE

ENGINE THRUST MANAGEMENT (3)

MANUAL CONTROL MODE

When the auto thrust function is not engaged, the EEC processes the EPR command signal according to the TRA. In manual mode the auto thrust is not engaged.

UGB13131 - U7ST0M0 - UM76D11AE000002



MANUAL CONTROL MODE

ENGINE THRUST MANAGEMENT (3)

BACK-UP N1 MODE

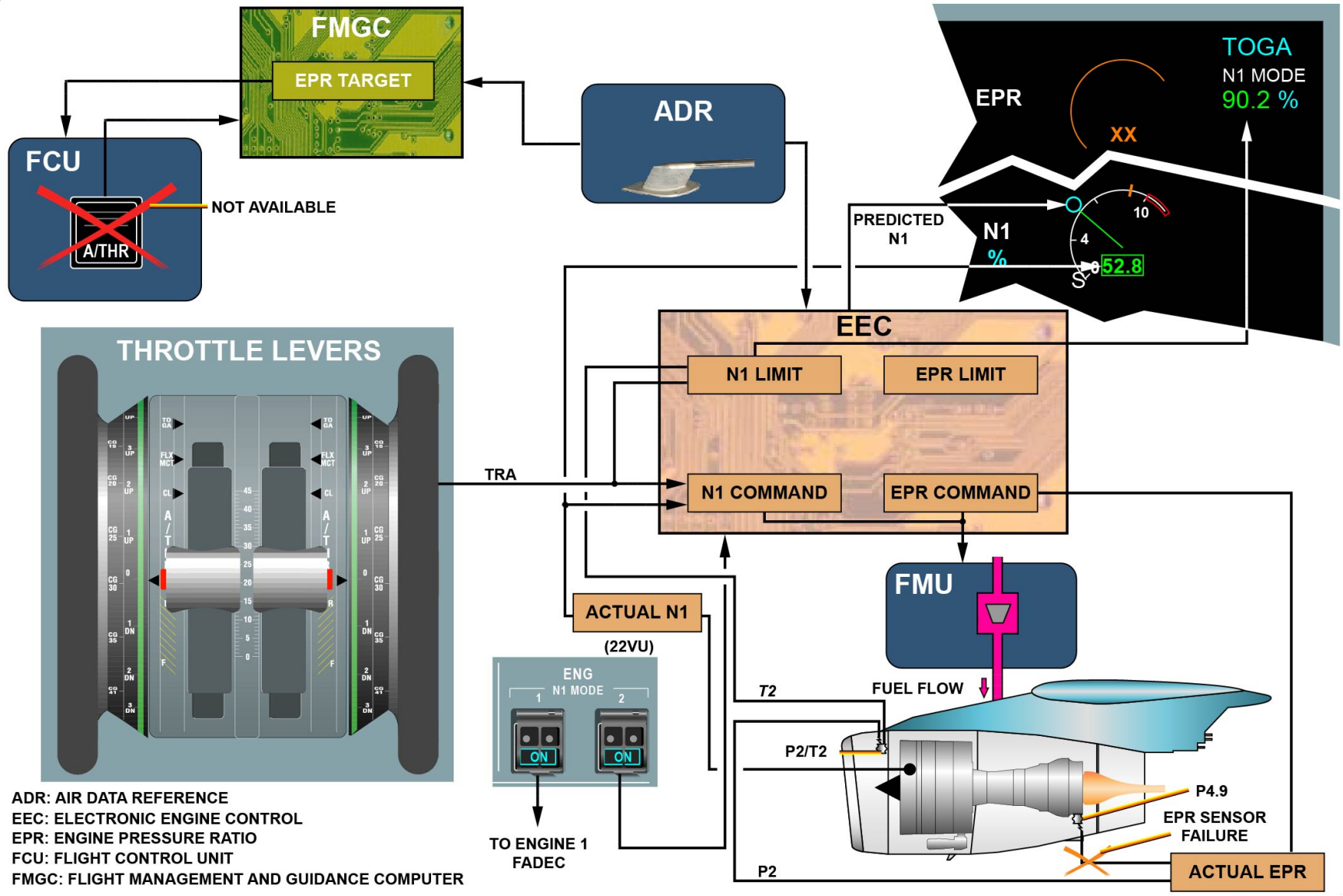
Here are presented two back-up N1 modes:
- rated N1 mode,
- unrated N1 mode.

RATED N1 MODE

In case of EPR sensor failure, i.e. P2 or P4.9, the EEC automatically reverts to the rated N1 mode. On the ECAM, the EPR indicator is crossed amber. The EEC uses TLA, ADR and T2. T2 is used in N1 rated mode to limit the engine thrust. To select N1 mode on both engines, the Engine N1 MODE P/Bs must be pressed in.

NOTE: The auto thrust function is not available in N1 mode. When the N1 MODE P/Bs are pressed in, the lights come ON and a signal is sent to their corresponding Full Authority Digital Engine Control (FADEC) system to confirm or to force the N1 MODE selection. On the ECAM, the EPR indicator is crossed amber and the N1 MODE limit is displayed instead of the EPR limit. On the N1 indicator, the predicted N1, i.e. the cyan circle, replaces the predicted EPR and an amber index appears to indicate the take-off N1 limit.

UGB13131 - U7ST0M0 - UM76D11AE000002



BACK-UP N1 MODE - RATED N1 MODE

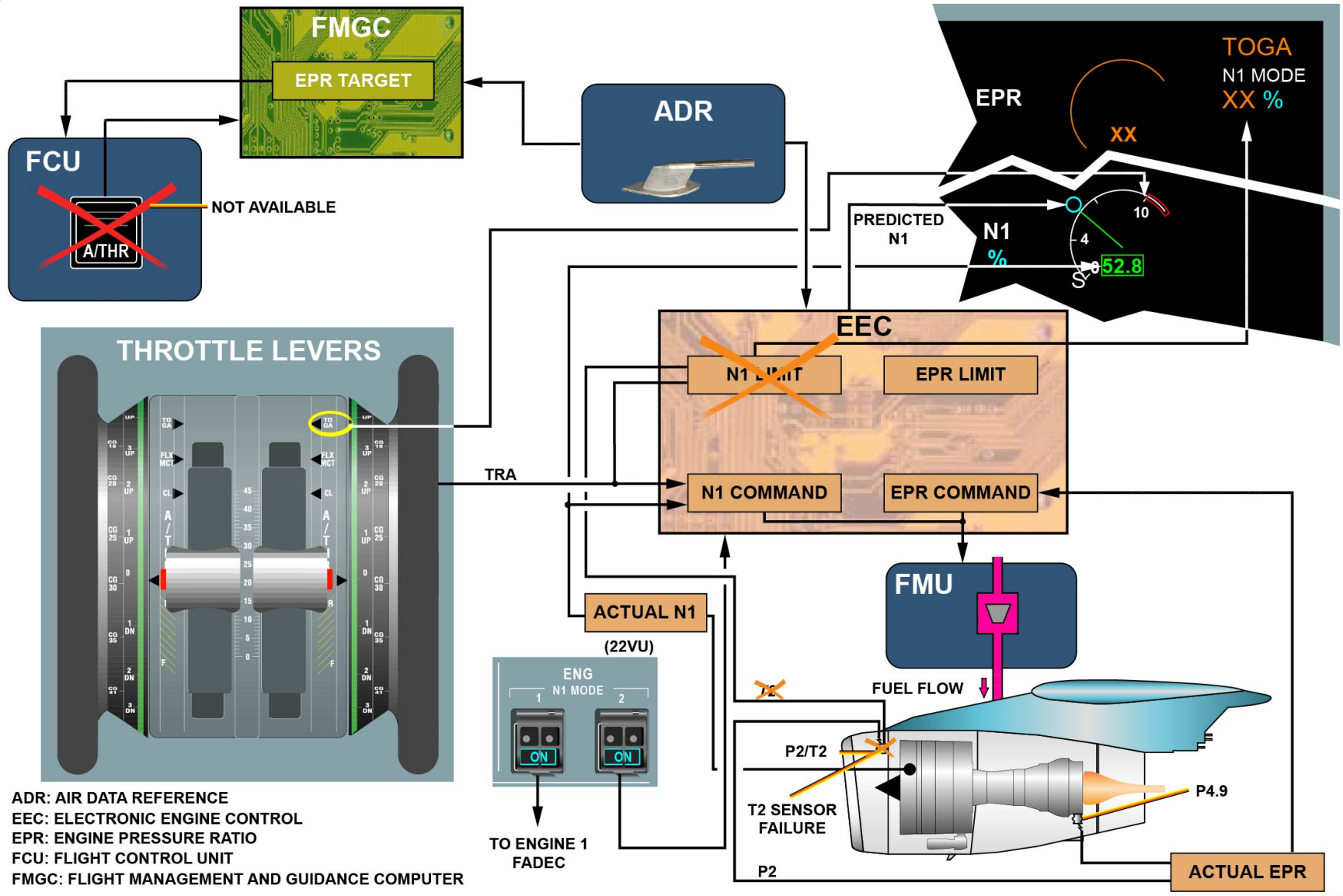
ENGINE THRUST MANAGEMENT (3)

BACK-UP N1 MODE (continued)

UNRATED N1 MODE

T2 is no longer available; the EEC reverts from the EPR mode to the unrated N1 mode. In this case the N1 limitation is no longer computed. The N1 command is directly related to the TRA.

NOTE: in unrated N1 mode, there is no longer an engine protection against over boost, e.g. Go-Around.



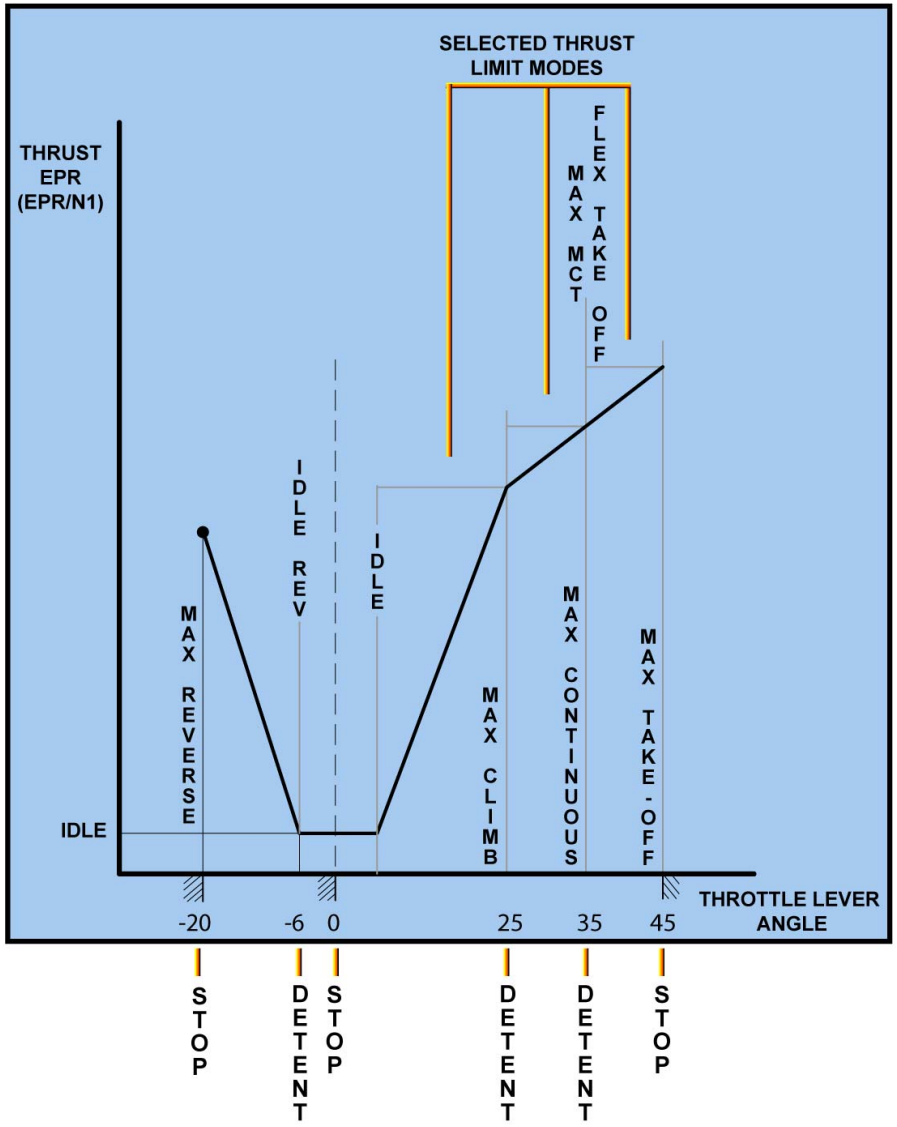
BACK-UP N1 MODE - UNRATED N1 MODE

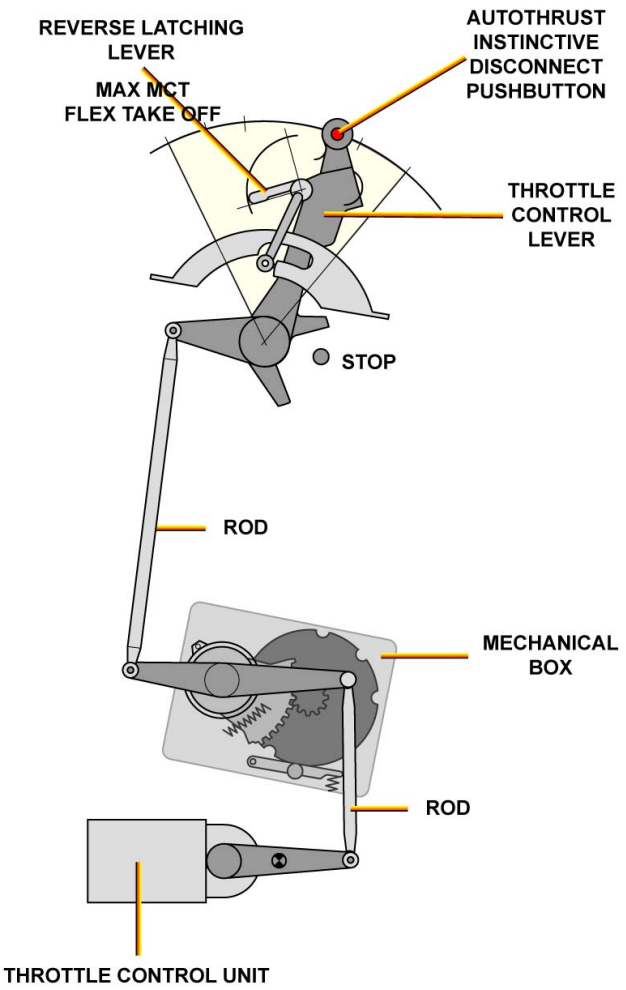
THROTTLE CONTROL SYSTEM D/O (3)

THROTTLE CONTROL LEVER

The Throttle control handle comprises:
o a throttle control lever which incorporates stop devices, autothrust instinctive disconnect pushbutton switch
o a graduated fixed sector
o a reverse latching lever.
The throttle control lever is linked to a mechanical rod. This rod drives the input lever of the throttle control artificial feel unit.
The throttle control lever moves over a range from -20 deg. TLA (Reverser Full Throttle stop) to +45 deg. TLA:
o -20 degrees TLA corresponds to Reverser Full Throttle stop
o +45 degrees TLA corresponds to Forward Full Throttle stop
An intermediate mechanical stop is set to 0 deg.TLA. This stop is overridden when the reverse latching lever is pulled up for selection of the reverse power. This stop is reset as soon as the throttle control lever is selected back to forward thrust area.
In the forward thrust area, there are two detent points, the MAX CLIMB detent point set to 25 deg.TLA and the MAX CONTINUOUS/FLEX TAKE-OFF detent point set to 35 deg.TLA.
In the reverse thrust throttle range, there is one detent point at - 6 deg.TLA. This position agrees with the selection of the thrust reverser command and the Reverse Idle setting.
In the middle throttle range (0deg. To 35 deg.TLA), the autothrust function can be active if engaged. This range agrees with the selection of MAX CLIMB or MAX CONTINUOUS thrust limit mode (in single operation). If the autothrust is not engaged, the engine control is manual.
In the forward range (35 deg. To 45 deg.TLA), the autothrust function cannot be activated (except in alpha floor condition).This range agrees with the selection of FLEX TAKE-OFF/MAX TAKE-OFF Mode.

UGB13131 - U7ST0M0 - UM76D5000000001





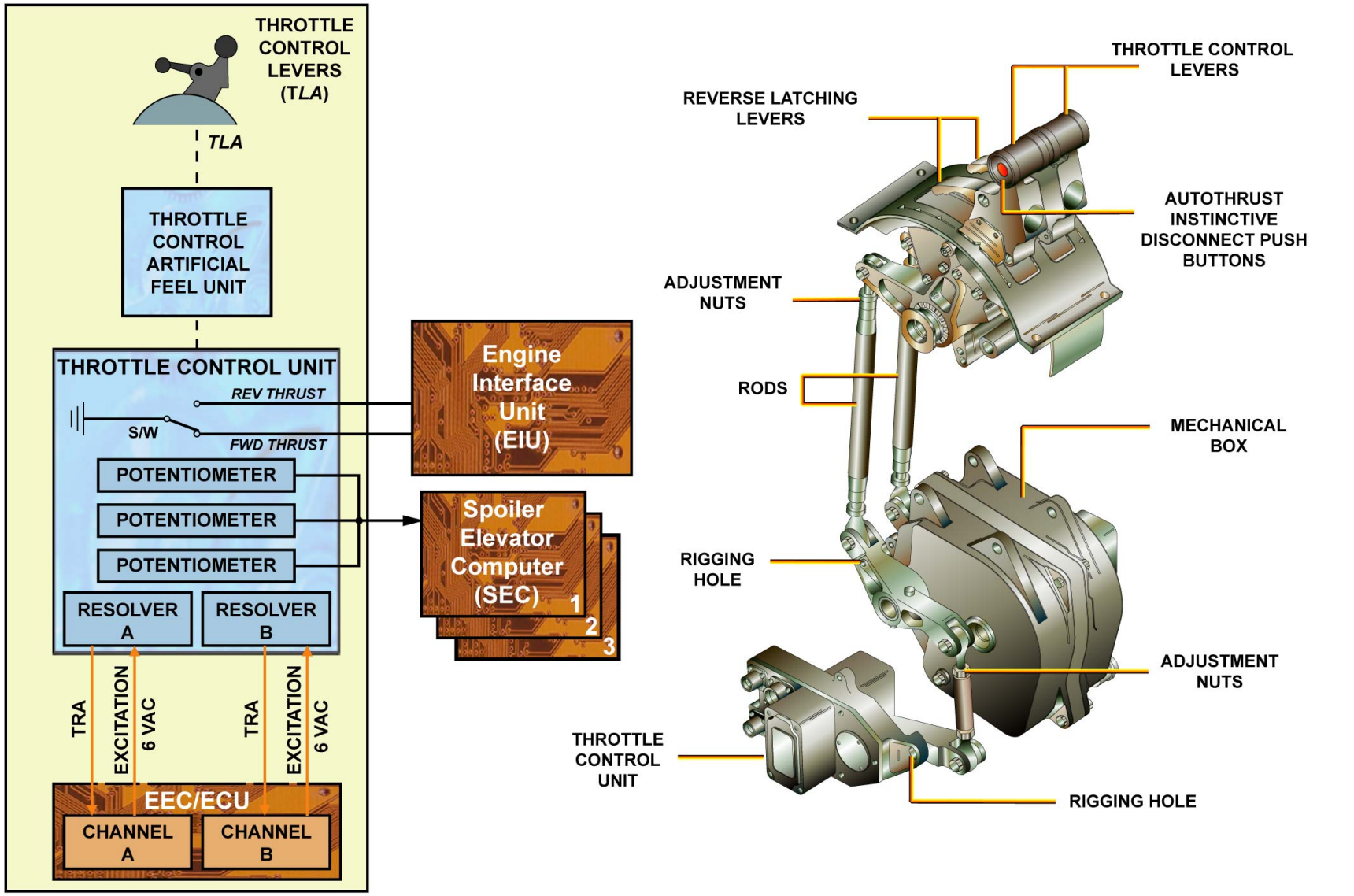
THROTTLE CONTROL LEVER

THROTTLE CONTROL SYSTEM D/O (3)

THROTTLE CONTROL UNIT

A mechanical rod transmits the throttle control lever movement. It connects the throttle artificial feel unit to the input lever of the throttle control unit. The throttle control unit comprises:
-An input lever
-Mechanical stops, which limit the angular range
-2 resolvers (one resolver per FADEC (ECU/EEC)
-6 potentiometers installed three by three
-A device, which drives the resolver and the potentiometer
-A pin device for rigging the resolver and potentiometers
-1 switch whose signal is dedicated to the EIU
-2 output electrical connectors
The input lever drives two gear sectors assembled face to face. Each sector drives itself a set of one resolver and three potentiometers. The relationship between the throttle lever angle and throttle resolver angle (TRA) IS LINEAR AND 1 DEG.TLA = 1.9 TRA. The accuracy of the throttle control unit (error between the input lever position and the resolver angle) is 0.5 deg.TRA. The maximum discrepancy between the signals generated by two resolvers is 0.25 deg.TRA.
The TLA resolver operates in two quadrants. The first quadrant is used for positive angles and the second quadrant for negative angles. Each resolver is dedicated to one FADEC channel (ECU / EEC) and receives its electrical excitation current (6 VAC) from the related FADEC channel (ECU / EEC)
The ECU considers a throttle resolver angle value:
o less than -47.5 deg.TRA
or
o greater than 98.8 deg.TRA as resolver position signal failure.
The ECU includes a resolver fault accommodation logic. This logic allows engine operation after a failure or a complete loss of the throttle resolver position signal.

UGB13131 - U7ST0M0 - UM76D5000000001



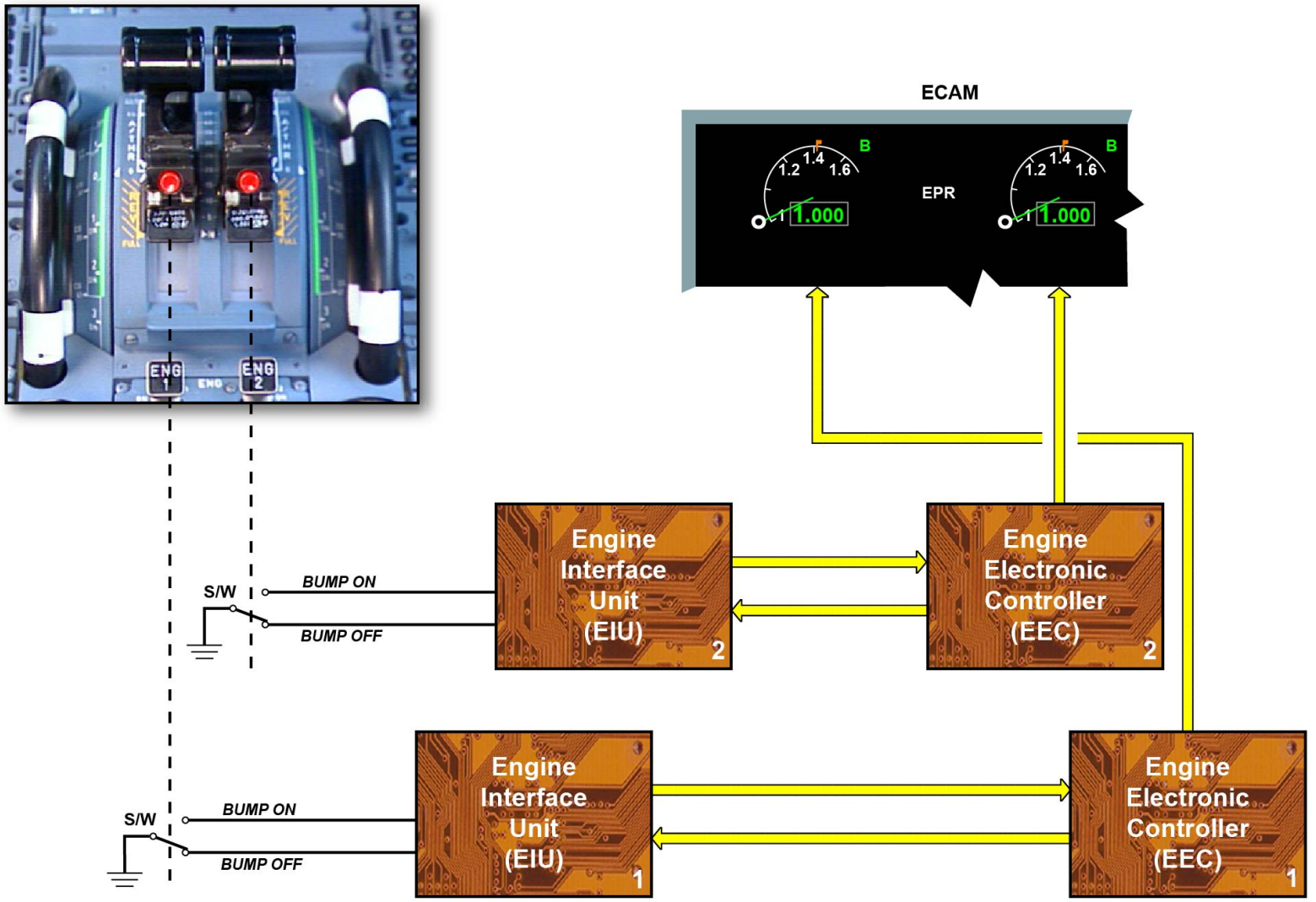
THROTTLE CONTROL UNIT

THROTTLE CONTROL SYSTEM D/O (3)

BUMP FUNCTION (IAE ENGINES ONLY)

If an airline requests the bump function, this function is selected in the aircraft by a pushbutton switch (one on each throttle control lever). With this switch, a signal can be sent to the two FADEC units at the same time through the Engine Interface Unit (EIU).

UGB13131 - U7ST0M0 - UM76D5000000001



BUMP FUNCTION (IAE ENGINES ONLY)

UGB13131 - U7ST0M0 - UM76D5000000001

ENGINE MONITORING D/O (3)

GENERAL

This system provides the vibration monitoring for both engines.

DUAL ACCELEROMETER

A dual accelerometer is installed on each engine. It provides the analog signals of N1 and N2 vibration frequencies. Only one sensor, A or B, of the dual accelerometer is used at a time and during one flight. It is automatically selected by the Engine Vibration Monitoring Unit (EVMU) at each flight, the second one is in back-up mode in case of failure. These accelerometers are also used for fan trim balance.

NOTE: In case of sensor failure, the transfer to the second sensor is carried out on the ground through the MCDU.

EVMU

An EVMU monitors the N1 and N2 vibration levels of both engines. The EVMU determines for each engine, the N1 and N2 vibration levels by analyzing:
- N1 and N2 speeds,
- dual accelerometer frequency signals.

The EVMU also computes the position and amplitude of the unbalance and is capable of on-board fan trim balancing.

VIBRATION INDICATION

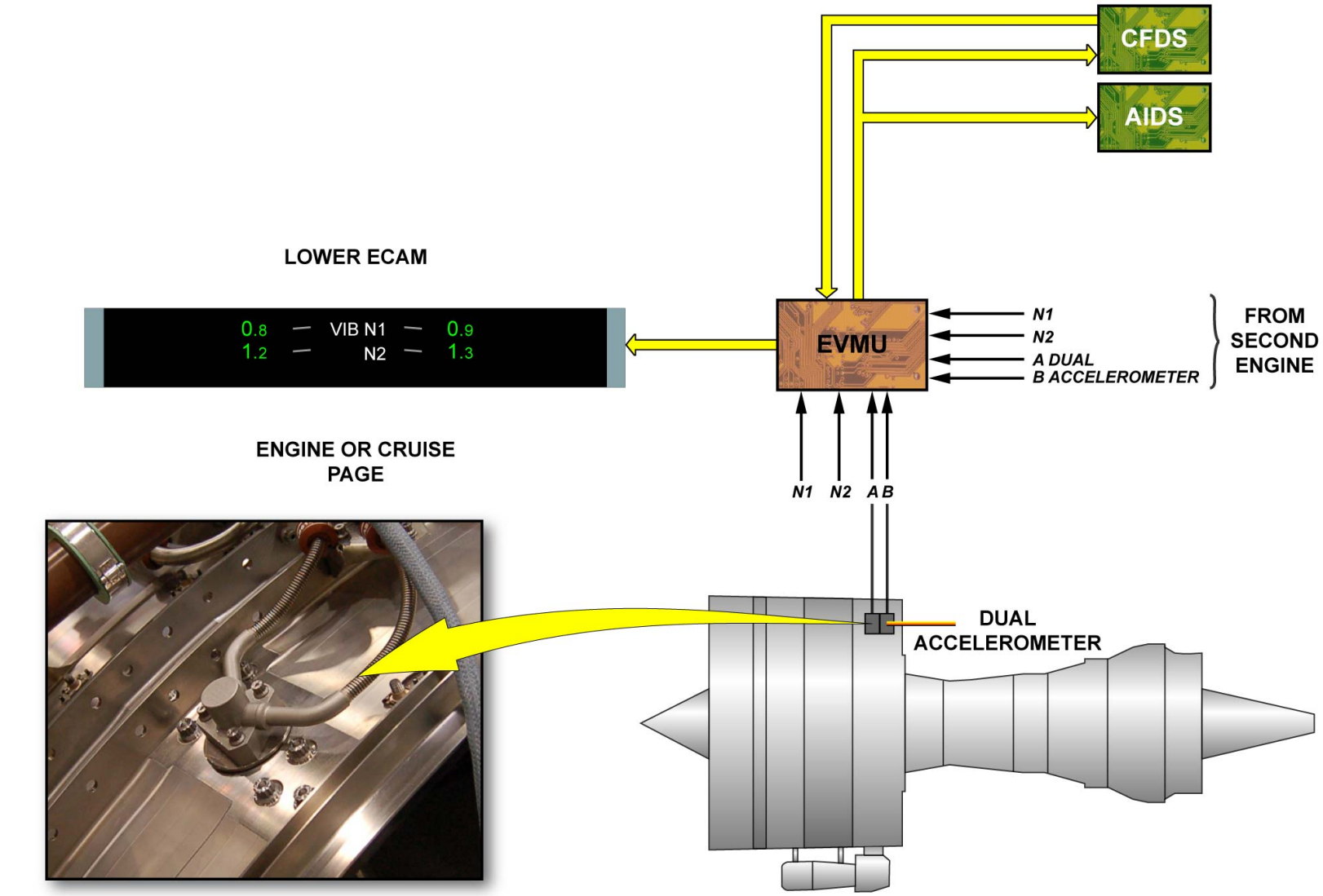
The N1 and N2 vibrations of the left and right engines are displayed on the ENGINE and CRUISE pages. The maximum value that can be displayed is of 10 units. 1 unit for N1 or N2 rotor corresponds to 0.3IPS (Inch Per Second).

INTERFACES

The EVMU interfaces with the ECAM, with the Centralized Fault Display System (CFDS) and the Aircraft Integrated Data System (AIDS). CFDS interface: maintenance fault messages and vibration data analysis. AIDS interface: performance data reports.

NOTE: There is no interface with the Electronic Engine Control (EEC).

UGB13131 - U7ST0M0 - UM77D2IAE000002



GENERAL - DUAL ACCELEROMETER ... INTERFACES

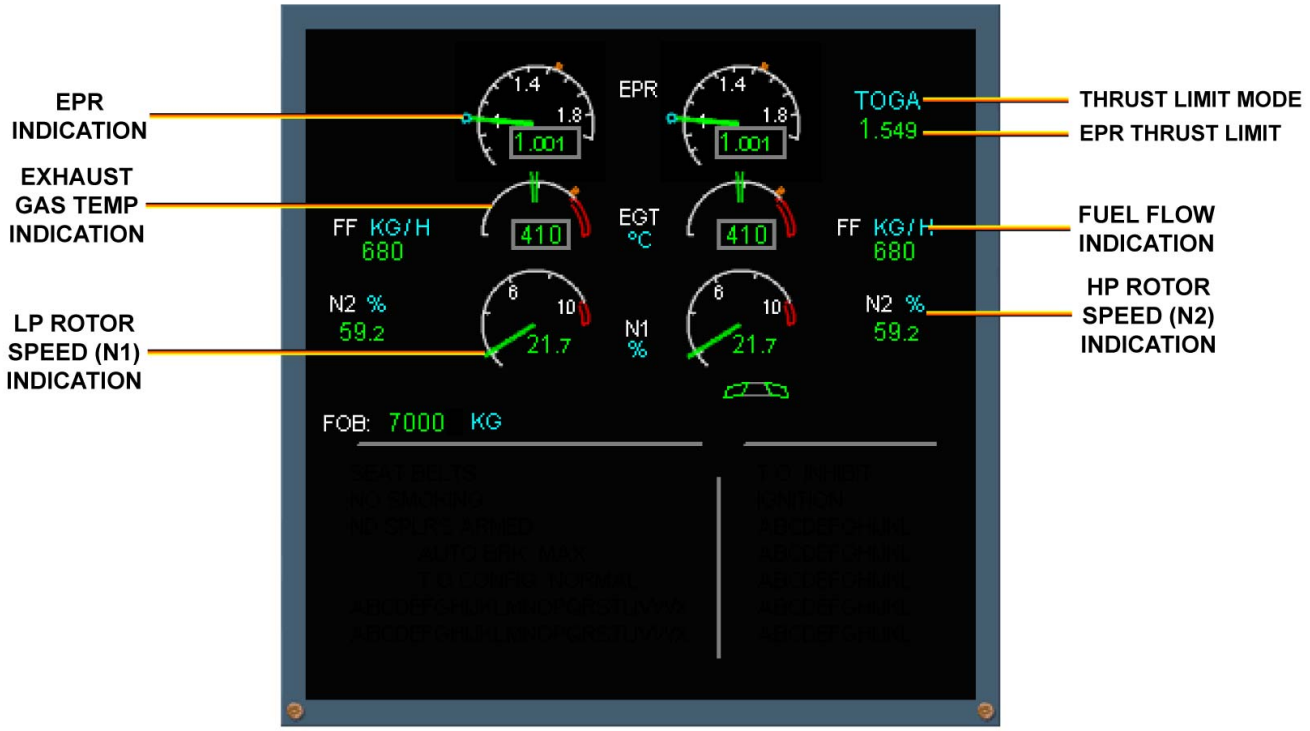
ENGINE MONITORING D/O (3)

PRIMARY PARAMETERS

The engine primary monitoring parameters displayed on the ECAM EWD are:

- Engine Pressure Ratio (EPR)
- Exhaust Gas Temperature (EGT)
- Low Pressure (LP) rotor speed indication (N1)
- Fuel Flow (FF) indication
- High Pressure (HP) rotor speed indication (N2)
- thrust limit mode
- EPR thrust limit

UGB13131 - U7ST0M0 - UM77D2IAE000002



PRIMARY PARAMETERS

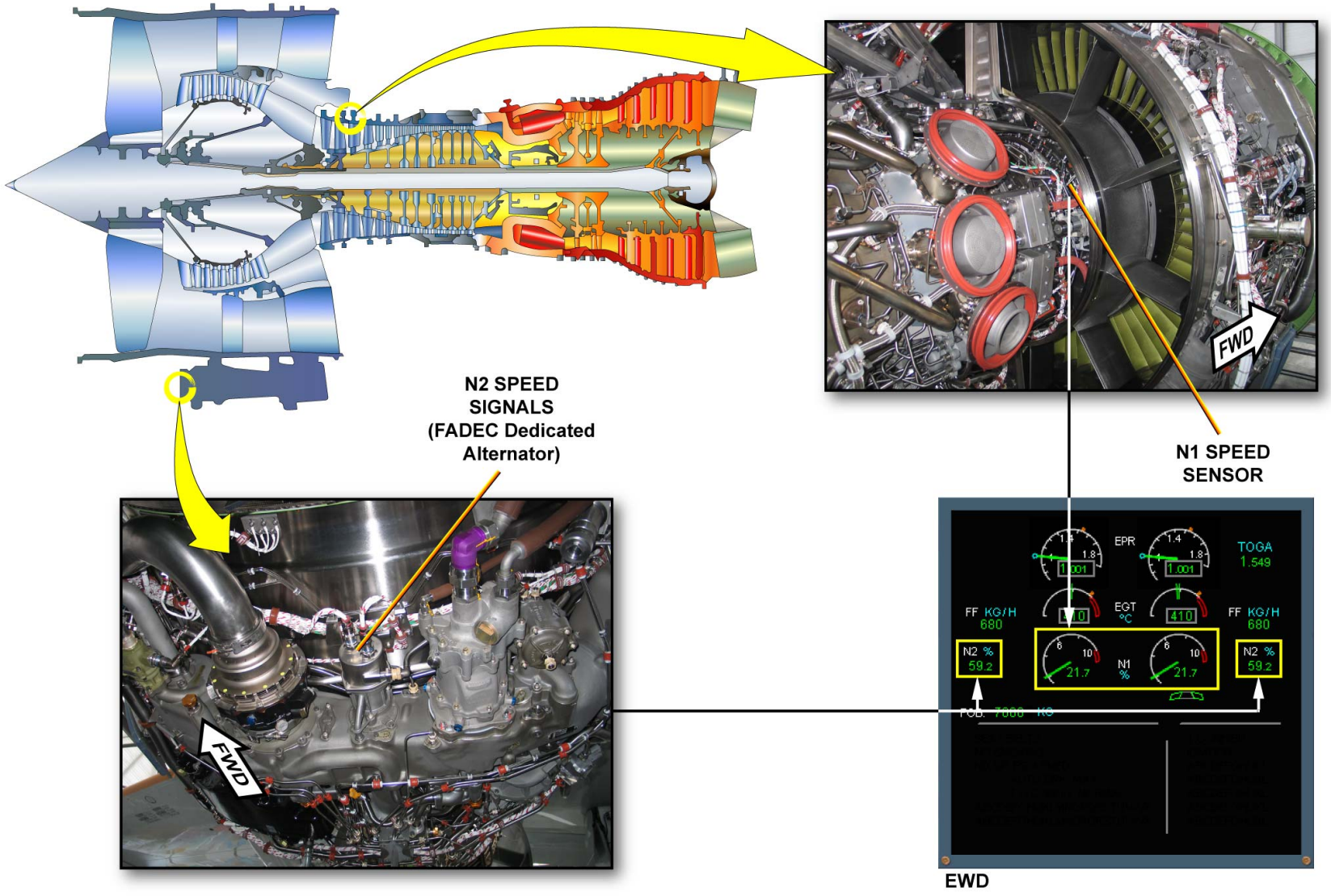
ENGINE MONITORING D/O (3)

PRIMARY PARAMETERS (continued)

ROTATIONAL SPEED PARAMETERS DESCRIPTION

The fan speed (N1) indicating system has 4 sensors:
o two sensors send N1 rotational speed signal to EEC channel A and B,
o one sensor is a spare for either EEC channel,
o one sensor sends N1 analog signals (trim balance sensor) to the Engine Vibration Monitoring Unit.
The N1 speed sensors and the trim balance sensor are installed on the front brackets attached to the No. 2 bearing support in the front bearing compartment.
The N1 rotational speed indication is shown on the ECAM EWD by a needle and a N1 digital indication display.
The N2 indicating system sends signals proportional to the High Pressure (HP) shaft rotational speed to the EEC for use in engine control computation, to the ECAM for visual display in the cockpit and to the Engine Vibration Monitoring Unit for use in processing engine vibration data. The N2 speed signal is sensed by the dedicated alternator, installed at the front face of the accessory gearbox.

UGB13131 - U7ST0M0 - UM77D2IAE000002



PRIMARY PARAMETERS - ROTATIONAL SPEED PARAMETERS DESCRIPTION

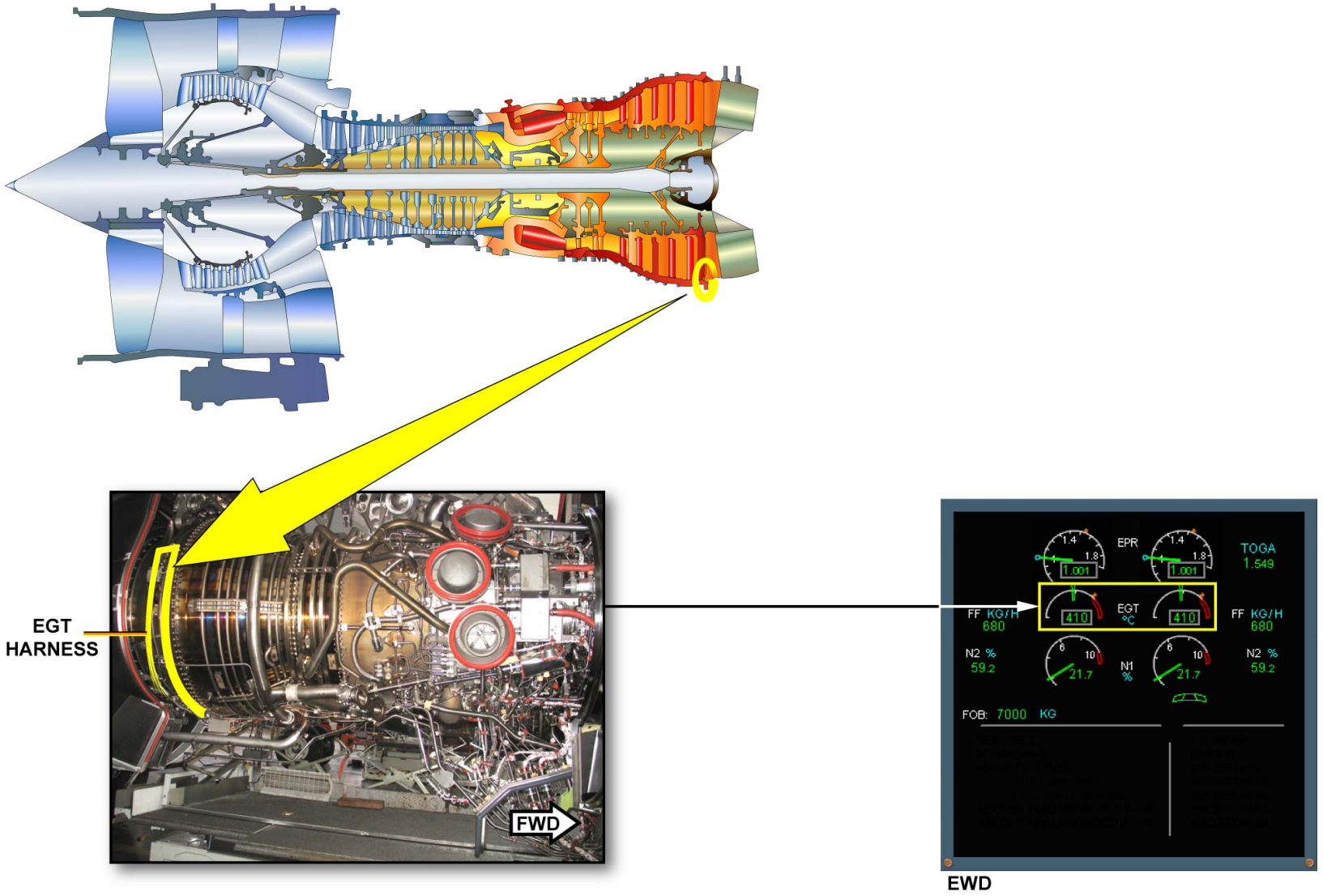
ENGINE MONITORING D/O (3)

PRIMARY PARAMETERS (continued)

LPT SECTION PARAMETERS DESCRIPTION

The engine EGT is sensed and averaged by 4 thermocouple probe assemblies are located at station 4.95 (LP turbine exhaust case strut) at 9.5, 7.5, 4.5 and 2 o'clock viewed from the rear. The actual engine EGT is displayed on the ECAM EWD with a needle and an EGT digital indication.

UGB13131 - U7ST0M0 - UM77D2IAE000002



PRIMARY PARAMETERS - LPT SECTION PARAMETERS DESCRIPTION

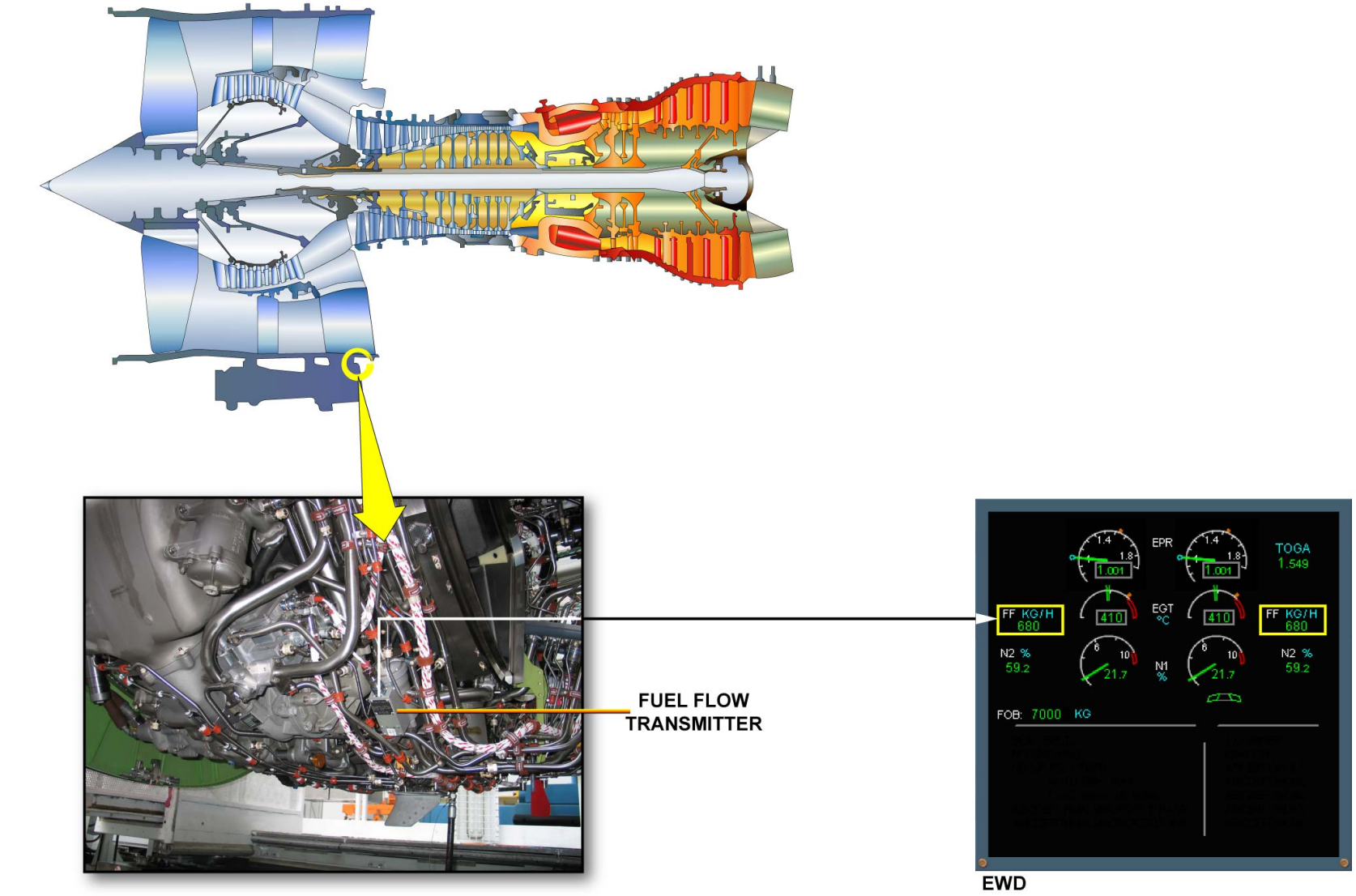
ENGINE MONITORING D/O (3)

PRIMARY PARAMETERS (continued)

FUEL FLOW PARAMETER DESCRIPTION

The fuel flow transmitter is installed in the fuel line between the fuel metering unit and the fuel distribution valve. It is mounted on the lower left-hand side of the fan case, rearward of the LP/HP fuel pump. The FF is shown on the ECAM EWD by a FF digital indication.

UGB13131 - U7ST0M0 - UM77D2IAE000002



PRIMARY PARAMETERS - FUEL FLOW PARAMETER DESCRIPTION

ENGINE MONITORING D/O (3)

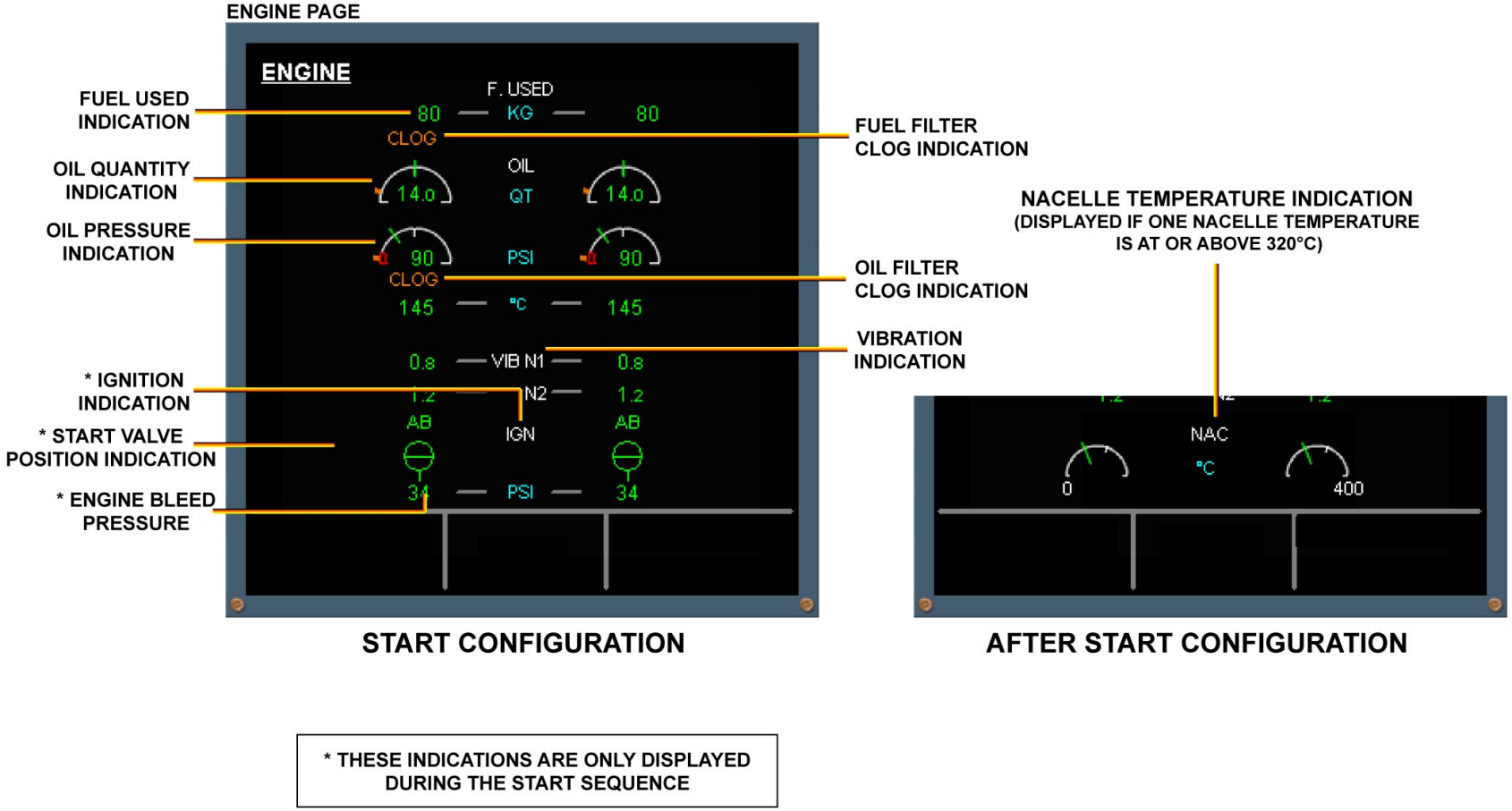
SECONDARY PARAMETERS

The engine secondary monitoring parameters are displayed on the ECAM lower SD when it is selected manually or automatically.
The engine secondary parameters that appear permanently on the ECAM ENGINE page are:
- fuel used indication,
- oil quantity indication,
- oil pressure indication,
- oil temperature indication,
- vibration indication

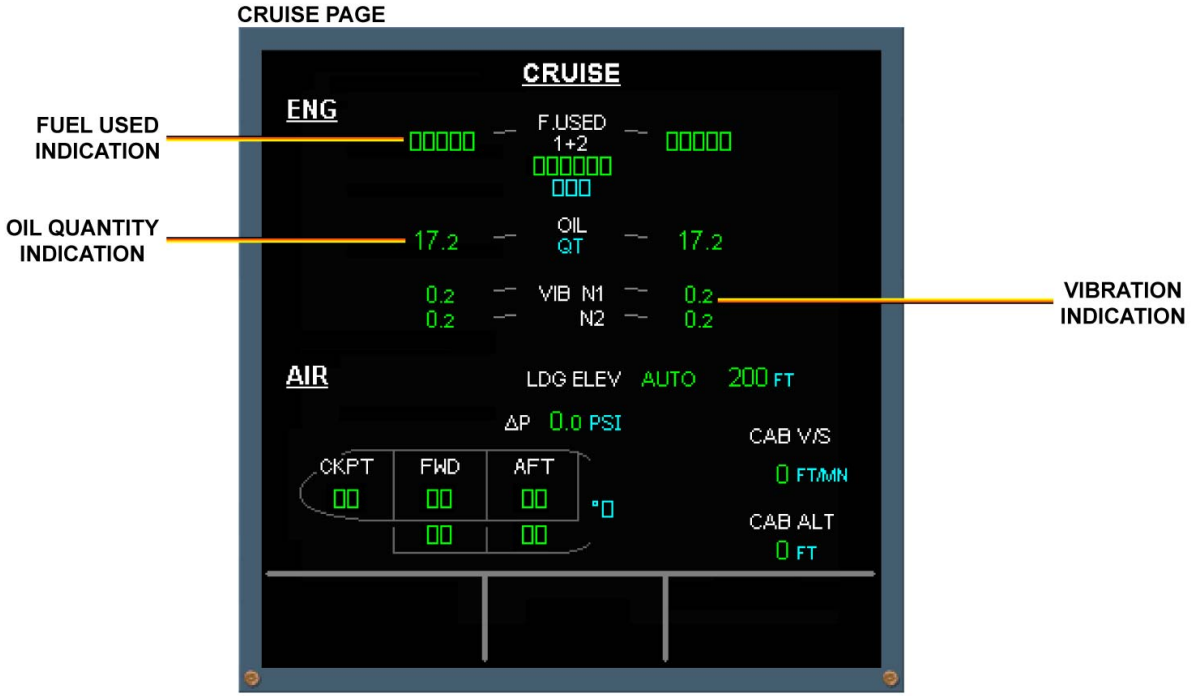
The engine secondary parameters not permanently displayed on the SD are:
- oil filter clog indication,
- fuel filter clog indication,
- nacelle temperature indication,
- ignition indication,
- start valve position indication,
- engine bleed pressure.

Fuel used, oil quantity and vibration indications are also displayed on the ECAM CRUISE page.

UGB13131 - U7ST0M0 - UM77D2IAE000002



SECONDARY PARAMETERS



SECONDARY PARAMETERS

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UGB13131 - U7ST0M0 - UM77D2IAE000002

ENGINE MONITORING D/O (3)

SECONDARY PARAMETERS (continued)

OIL PARAMETERS DESCRIPTION

The oil quantity XMTR is located in the oil tank. It is displayed on the ECAM SD

The oil pressure XMTR is bolted to a bracket on the top left side of the engine fan case. It is displayed on ECAM the SD.

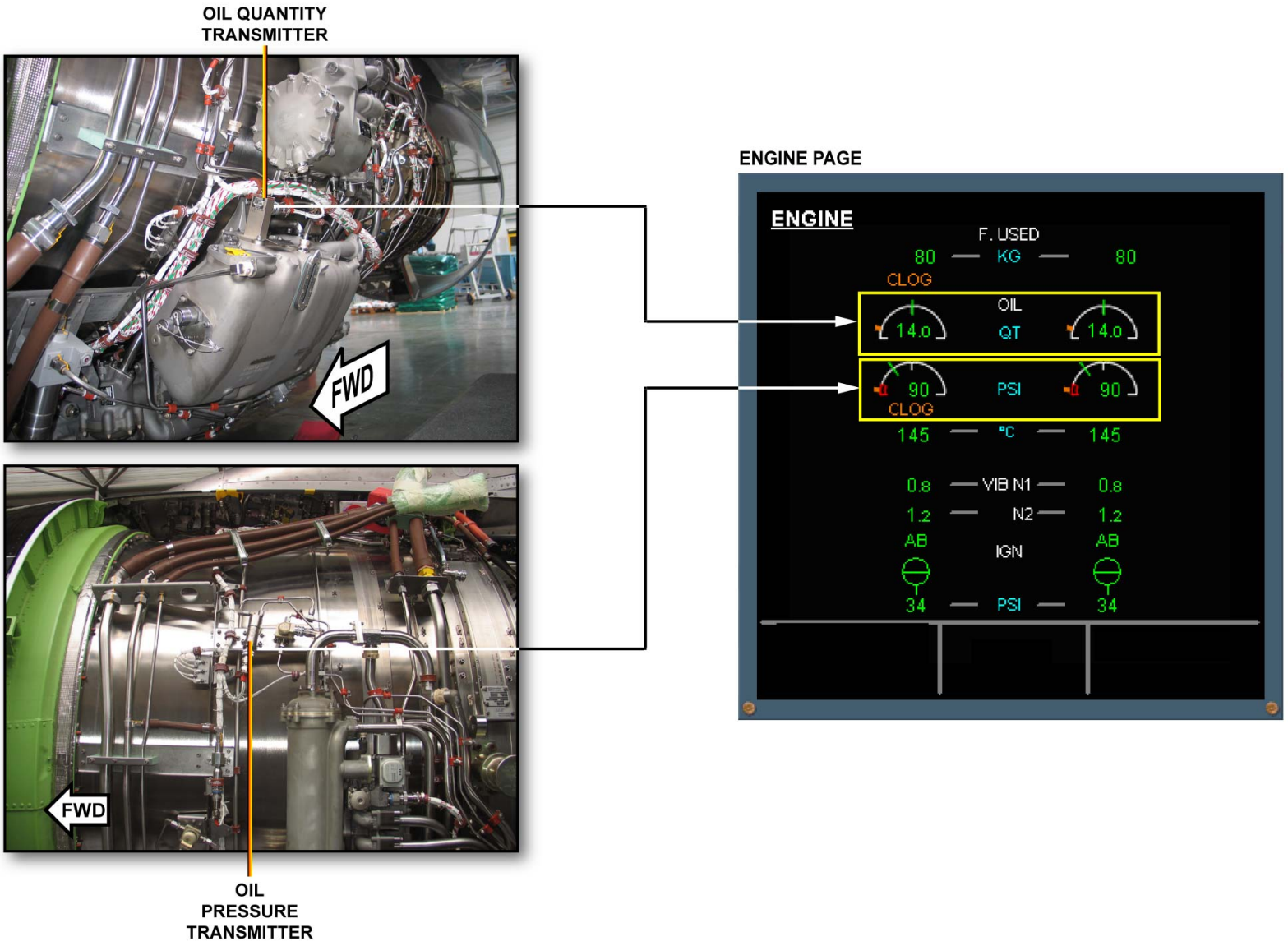
The scavenge oil temperature thermocouple is located in the combined scavenge line between the master magnetic chip detector and the scavenge filter for indication in the cockpit.

The oil temperature is sensed by a dual resistor unit. The unit has a sealed, wire-wound resistance element. This element causes a linear change in the DC resistance when exposed to a temperature change.
Temperature measurement range: -60°C to 250°C.

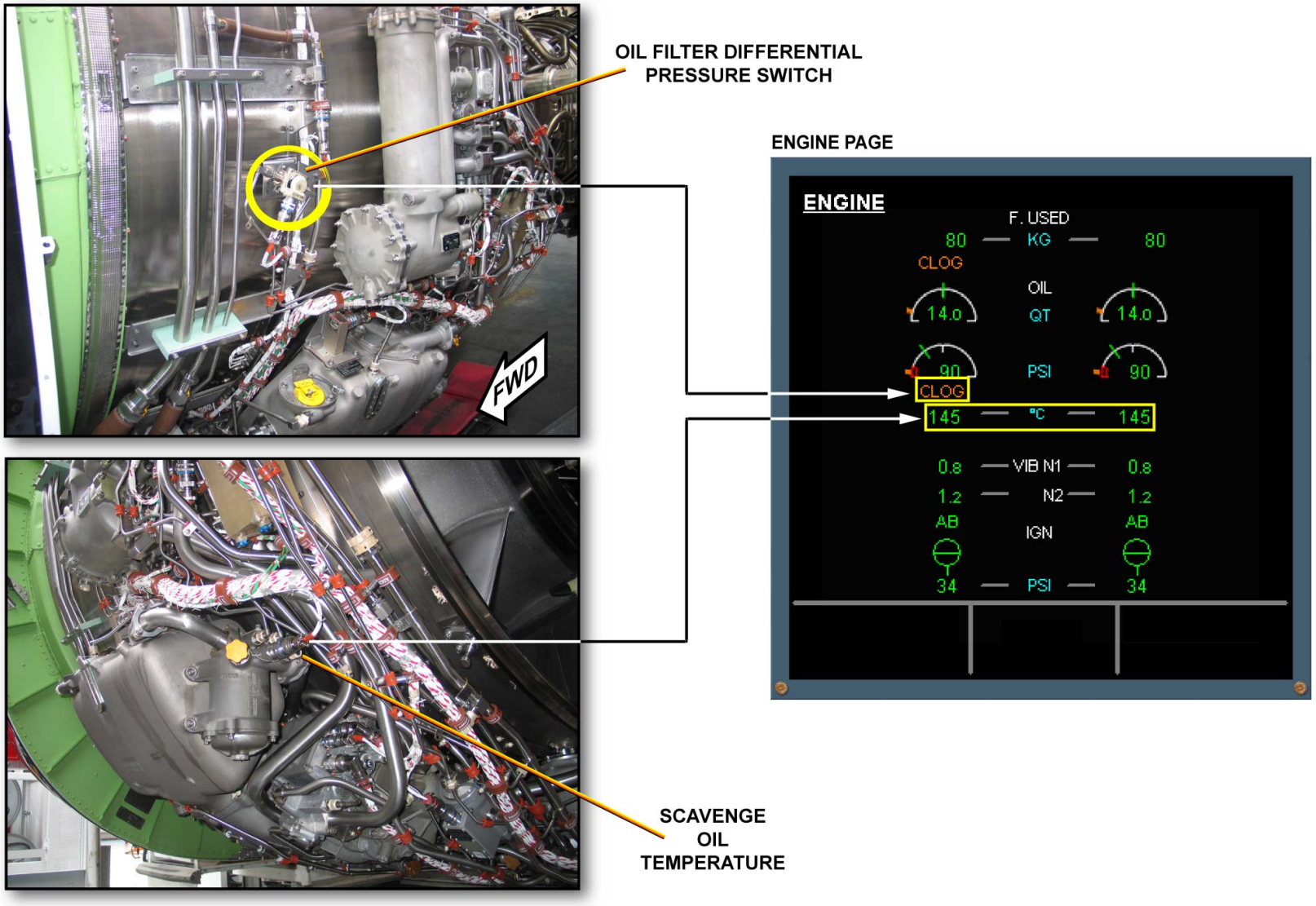
The scavenge filter differential pressure switch is installed on a bracket at the top left side of the engine fan case. The switch is connected to ports on the filter housing.

The differential pressure switch is set to operate when the differential pressure increases and gets to 12 psi plus or minus 2 psi

UGB13131 - U7ST0M0 - UM77D2IAE000002



SECONDARY PARAMETERS - OIL PARAMETERS DESCRIPTION



SECONDARY PARAMETERS - OIL PARAMETERS DESCRIPTION

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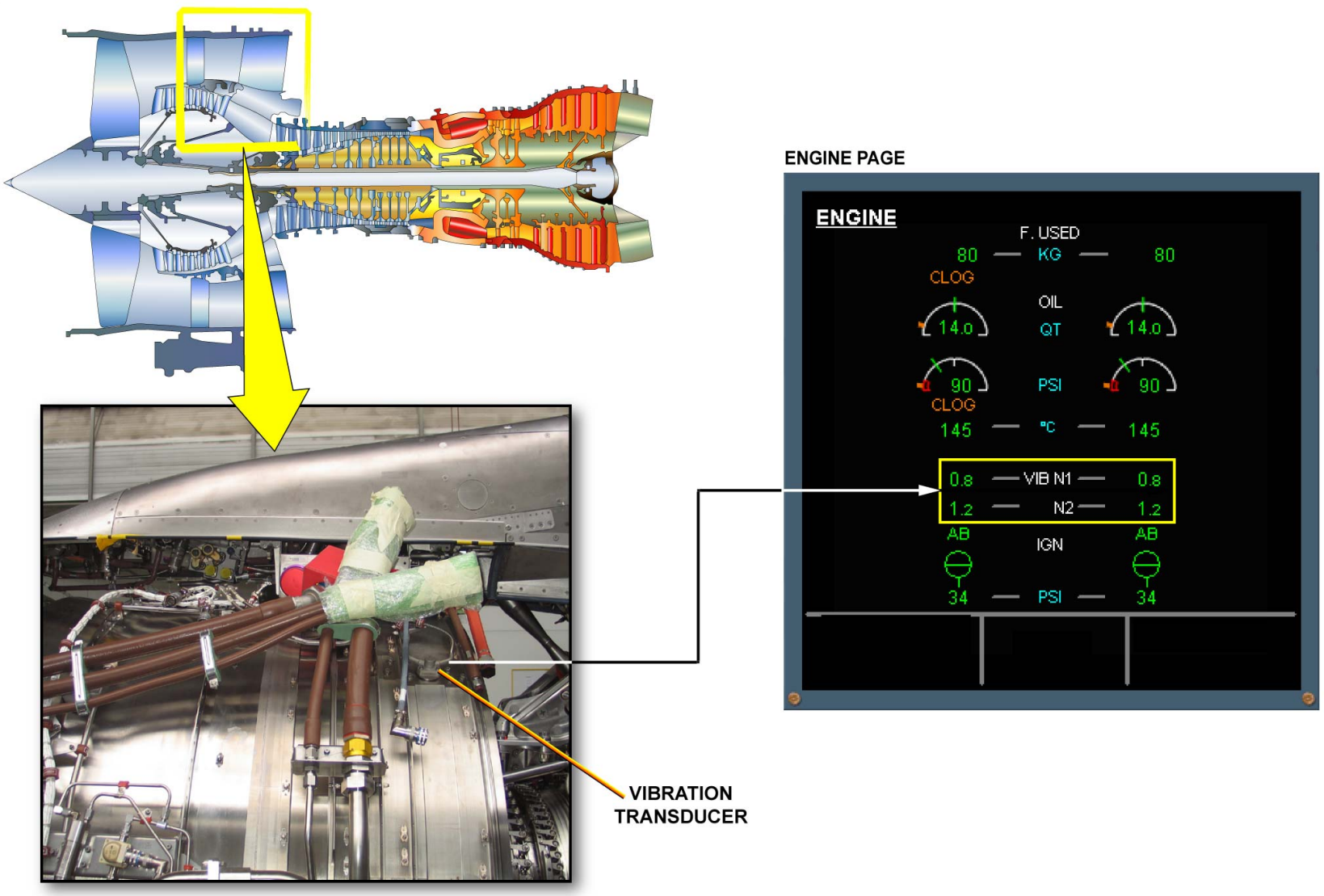
ENGINE MONITORING D/O (3)

SECONDARY PARAMETERS (continued)

VIBRATION PARAMETERS DESCRIPTION

The system monitors engine vibration for engine 1 and engine 2. On each engine fan case, a vibration transducer does monitoring. This produces an electrical signal in proportion to the vibration detected and sends it to the cockpit. Two channels come from each engine. Each vibration transducer is installed in the fan case at the top left side of the engine. It is attached with bolts and is installed on a mounting plate.



SECONDARY PARAMETERS - VIBRATION PARAMETERS DESCRIPTION

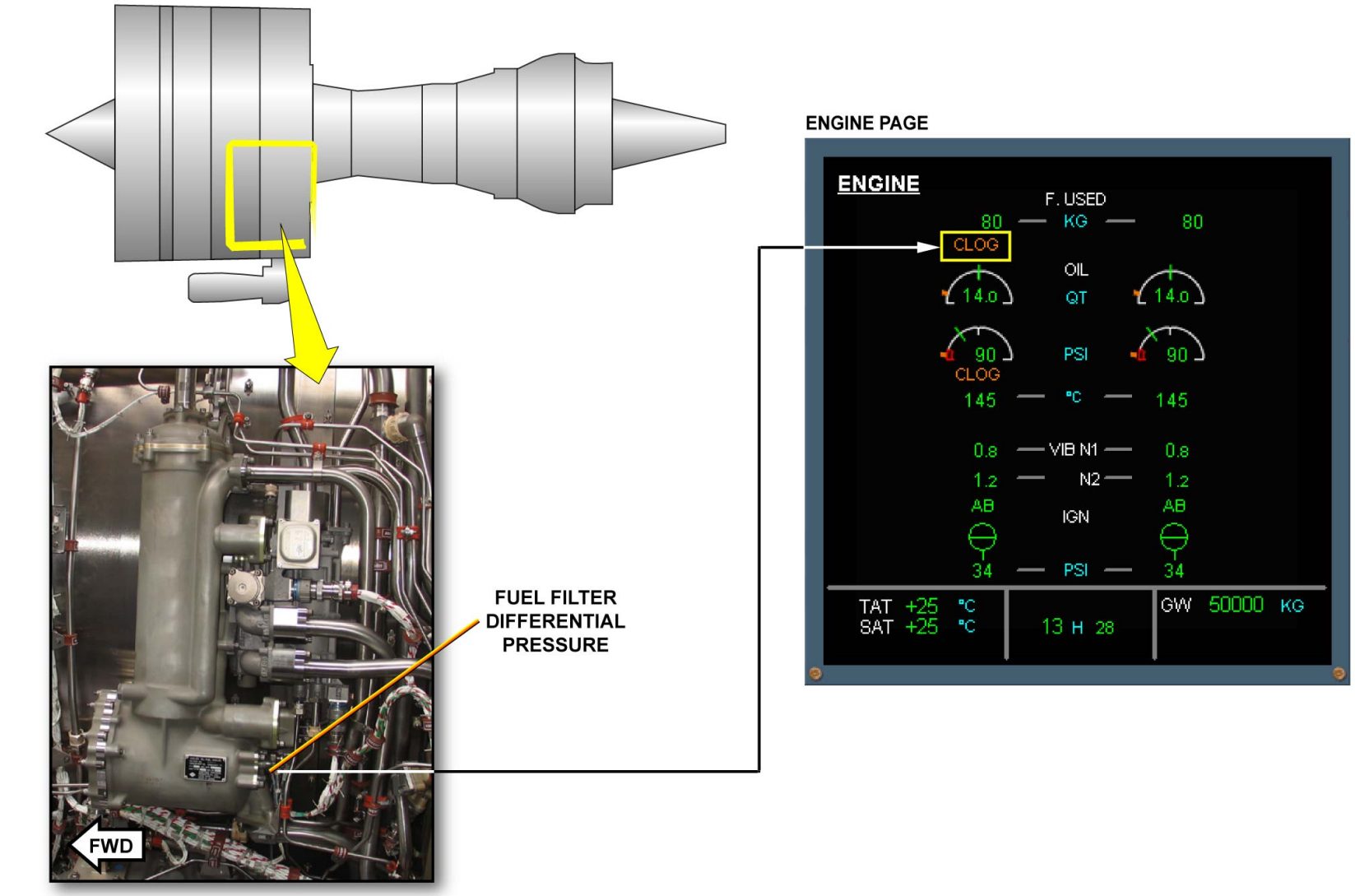
ENGINE MONITORING D/O (3)

SECONDARY PARAMETERS (continued)

FUEL PARAMETERS DESCRIPTION

The fuel used value computed by the Full Authority Digital Engine Control (FADEC) is displayed in green on the ECAM SD.
A CLOG message appears in amber with an ECAM message only when the differential pressure across the fuel filter is too high.

UGB13131 - U7ST0M0 - UM77D2IAE000002



SECONDARY PARAMETERS - FUEL PARAMETERS DESCRIPTION

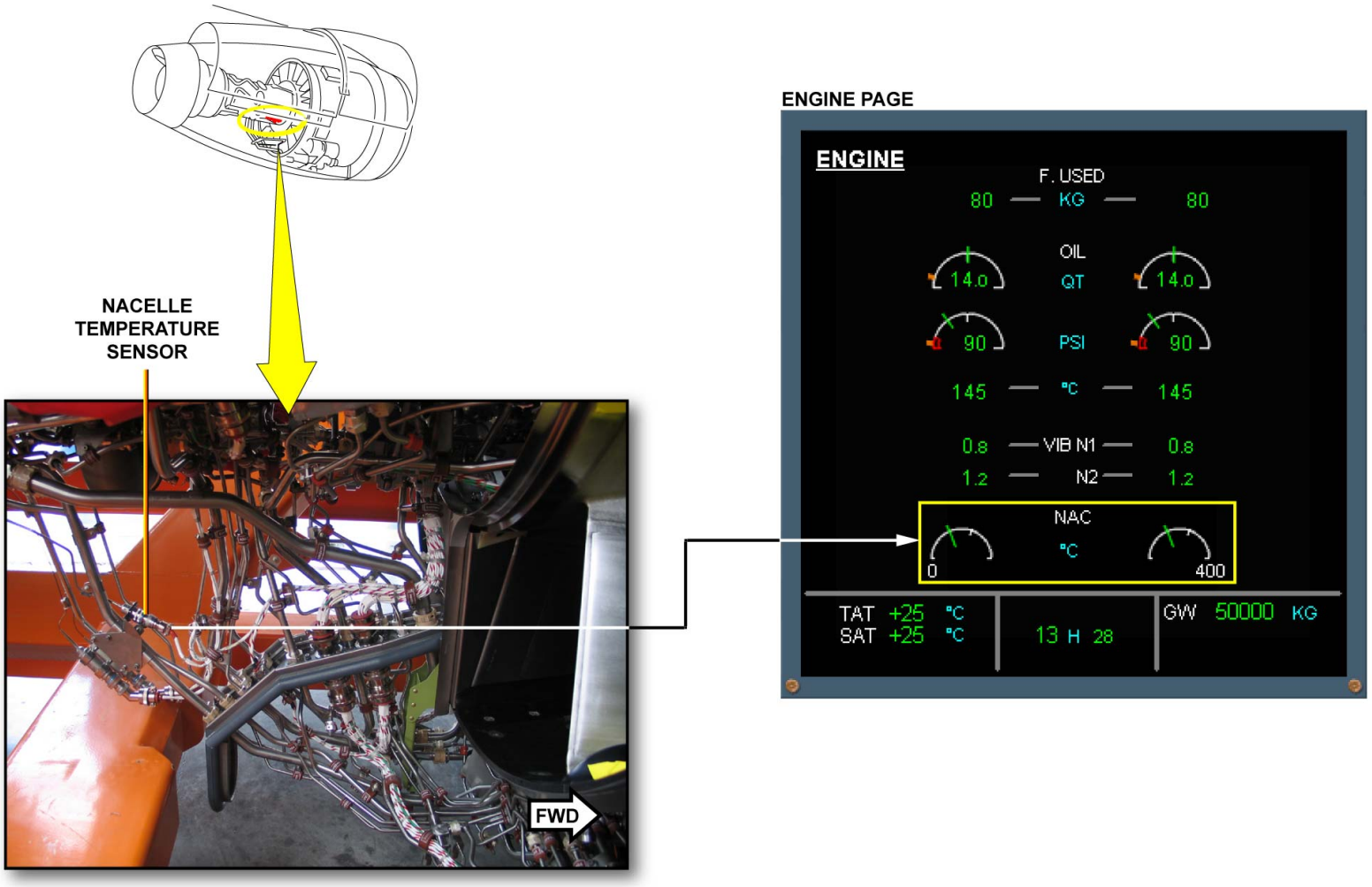
ENGINE MONITORING D/O (3)

SECONDARY PARAMETERS (continued)

NACELLE TEMPERATURE INDICATION

A temperature probe installed in the nacelle core zone ventilation air exit monitors the nacelle temperature.
The nacelle temperature sensor can give the indication to the ECAM SD.

UGB13131 - U7ST0M0 - UM77D2IAE000002



SECONDARY PARAMETERS - NACELLE TEMPERATURE INDICATION

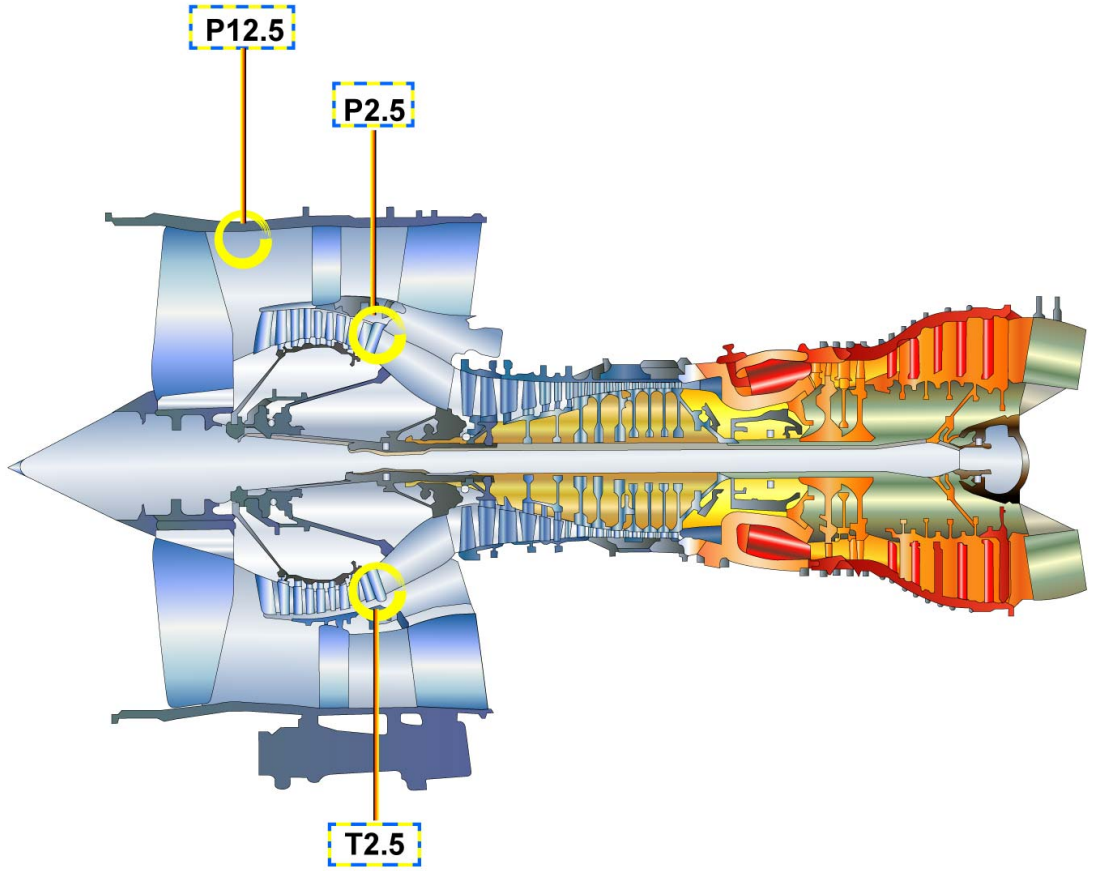
ENGINE MONITORING D/O (3)

OPTIONAL PARAMETERS

These additional engine sensors are optional and dedicated to the engine condition monitoring through the AIDS. These engine parameters (P12.5, P2.5, T2.5) are available on the EEC data bus output if installed on the engine:

- P12.5 sensor supplies air pressure from the fan exit,
- P2.5 sensor supplies air pressure from the LP compressor exit,
- T2.5 sensor supplies air pressure from the LP compressor exit.

UGB13131 - U7ST0M0 - UM77D2IAE000002



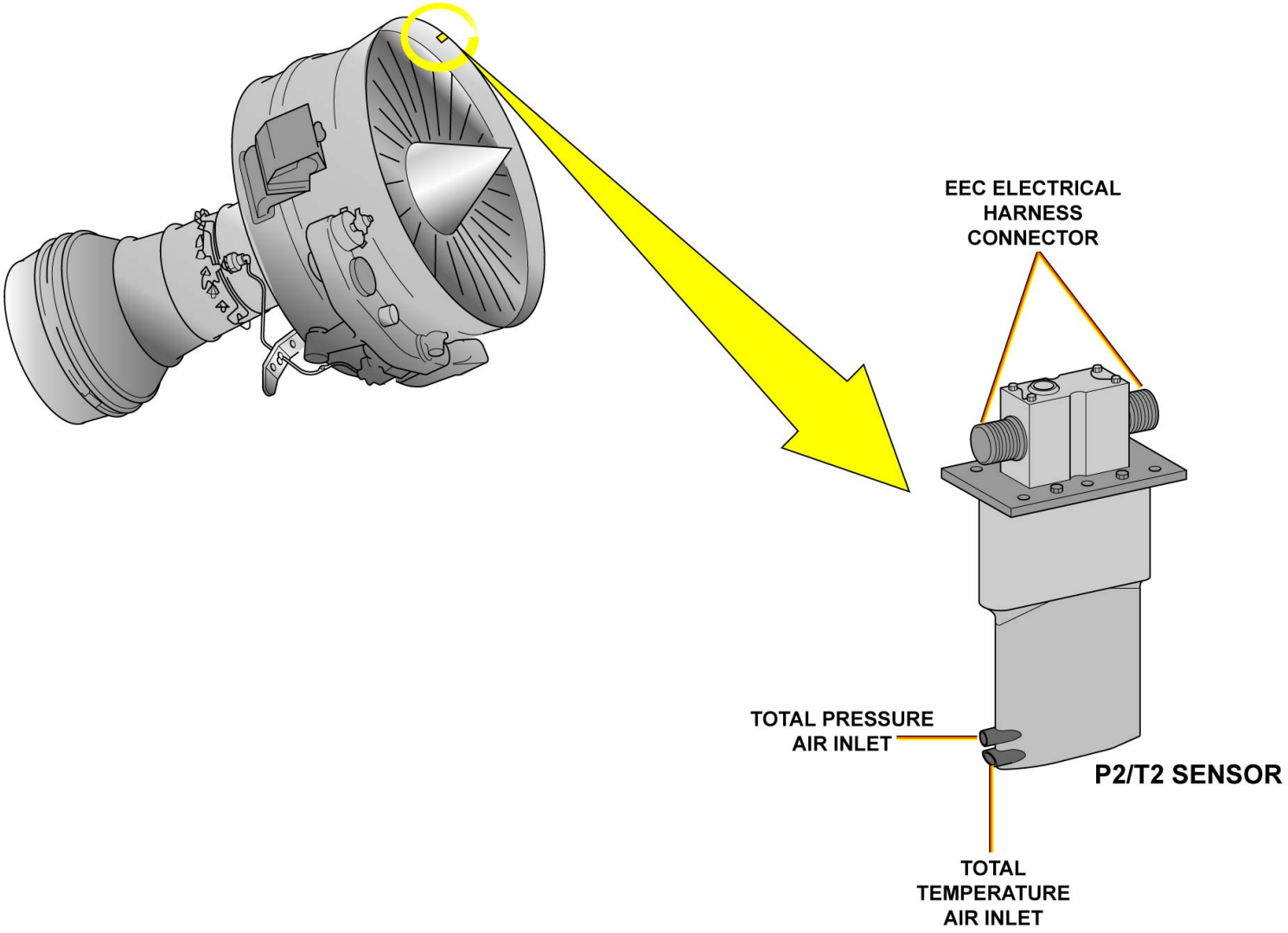
OPTIONAL PARAMETERS

ENGINE MONITORING D/O (3)

INLET AIR STREAM PARAMETERS DESCRIPTION

The P2/T2 sensor is located near the 12 o'clock position of the inlet cowl. It measures total pressure and temperature in the inlet air stream of the engine forward of the engine front flange.

UGB13131 - U7ST0M0 - UM77D2IAE000002



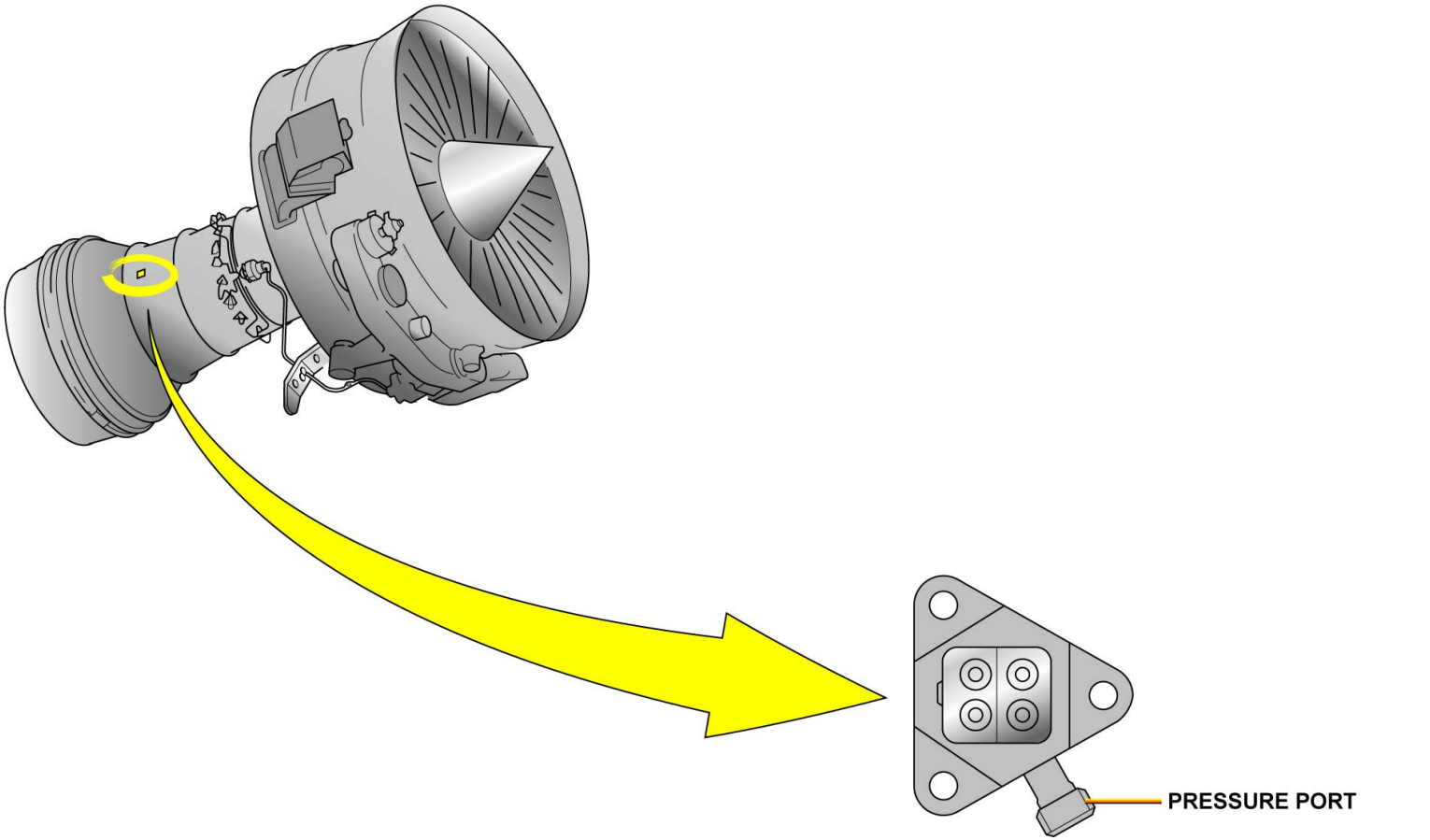
INLET AIR STREAM PARAMETERS DESCRIPTION

ENGINE MONITORING D/O (3)

HP COMPRESSOR EXIT PARAMETERS DESCRITPION

The P3/T3 sensor monitors the pressure and temperature at the exit of the HP compressor. The combined sensor houses two thermocouples and one pressure inlet port. Each thermocouple sends an independent electrical signal, proportional to the temperature, to one channel of the Electronic Engine Control (EEC).
The function of the P3/T3 sensor is to give performance data to the EEC for starting and during transient and steady state operation of the engine.

UGB13131 - U7ST0M0 - UM77D2IAE000002



PRESSURE AND TEMPERATURE SENSOR (P3/T3)

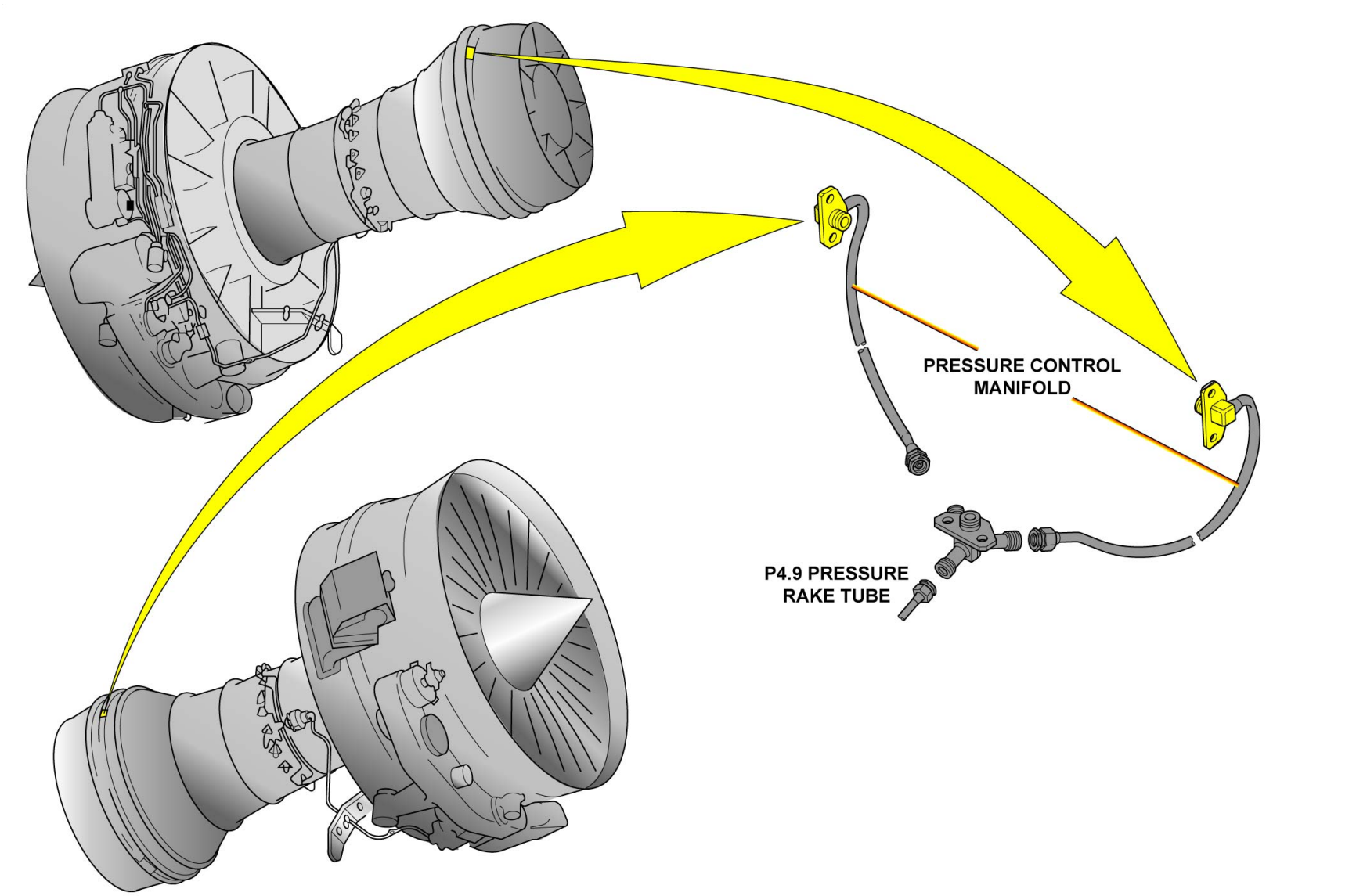
HP COMPRESSOR EXIT PARAMETERS DESCRITPION

ENGINE MONITORING D/O (3)

TURBINE EXHAUST CASE PARAMETERS DESCRITPION

Pressure sensing instrumentation is included in the leading edge of specific turbine exhaust case struts. Struts 4, 7 and 10 contain the pressure sensing ports. The pressure value is then ducted into a manifold, which supplies an overall turbine exhaust pressure average (P4.9). A tube from this manifold is connected to the Electronic Engine Control (EEC).
A pressure transducer installed within the EEC converts the average pressure at station 4.9 into a useable electronic signal (proportional to the pressure) that can be processed and used by the EEC as required to control the engine, perform fault detection.

UGB13131 - U7ST0M0 - UM77D2IAE000002



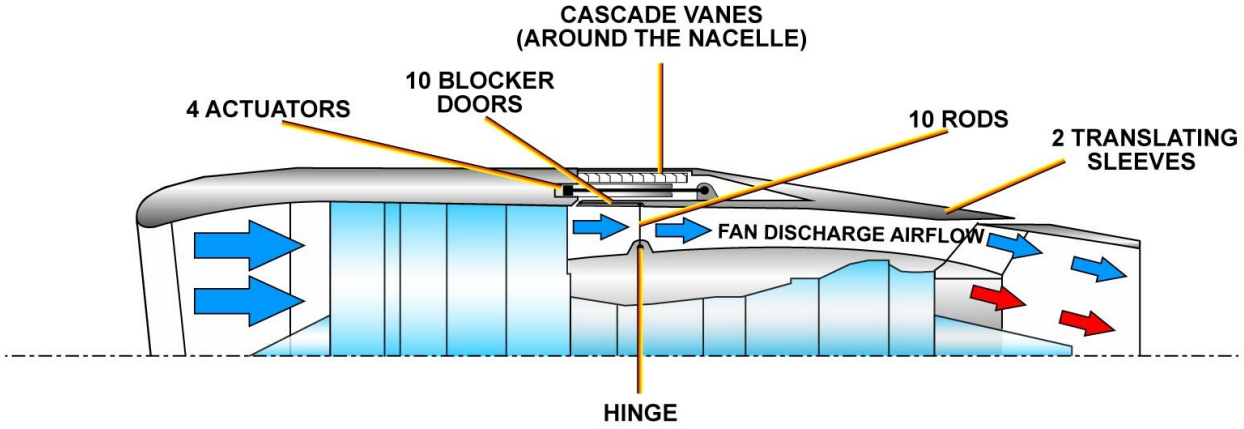
TURBINE EXHAUST CASE PARAMETERS DESCRITPION

THRUST REVERSER SYSTEM PRESENTATION (2)

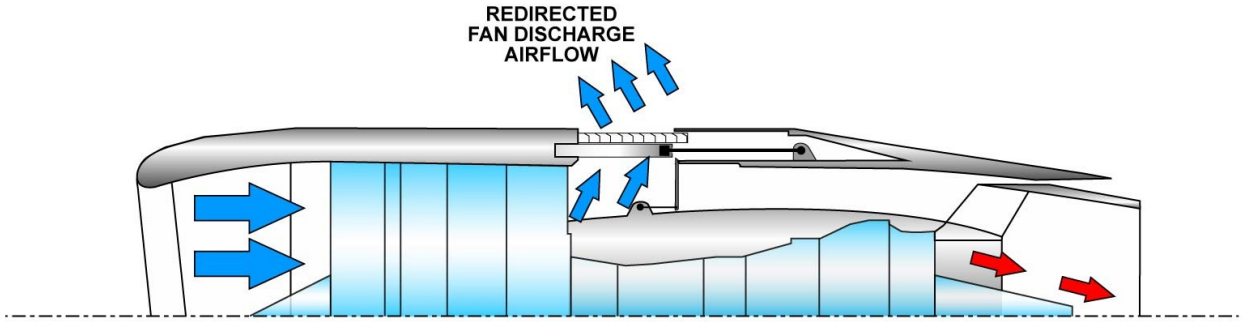
REVERSER DESIGN

The thrust reverser system is of the aerodynamic blockage type. It consists of two translating sleeves, blocker doors and cascade vanes to redirect fan discharge airflow. The thrust reverser system is designed for use on the ground only to reduce aircraft landing roll.

STOWED



DEPLOYED



REVERSER DESIGN

THRUST REVERSER SYSTEM PRESENTATION (2)

HYDRAULIC SUPPLY

The thrust reverser system is hydraulically actuated utilizing the aircraft hydraulic pressure from the corresponding engine. The thrust reverser system is isolated from the hydraulic supply by a Shut-Off Valve (SOV).

ACTUATION

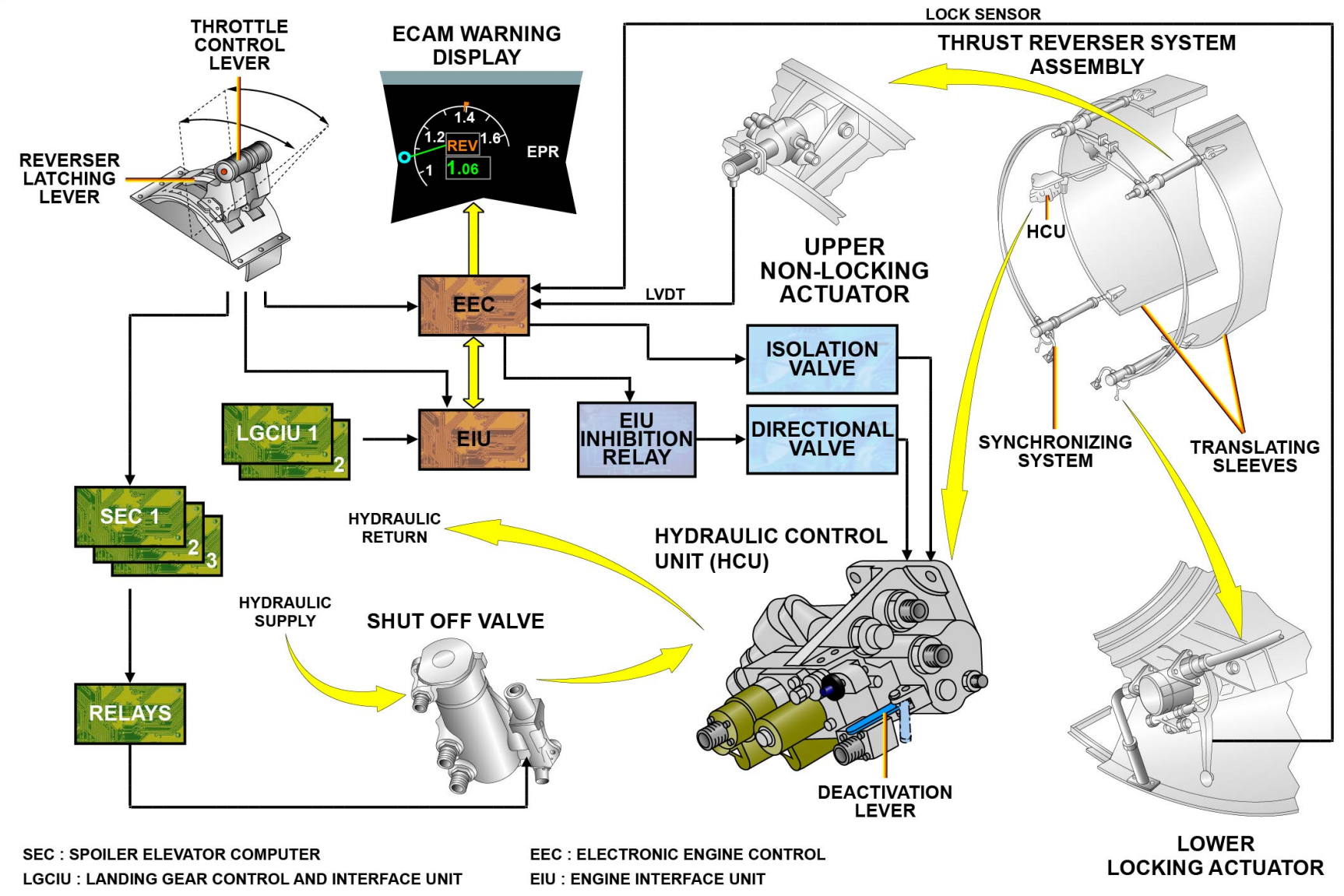
Each translating sleeve is operated by two hydraulic actuators. The actuators receive fluid from the Hydraulic Control Unit (HCU), which is controlled by the Electronic Engine Control (EEC). When the deploy sequence is commanded the pressure in the lower actuators releases the locks as the four actuator pistons move rearward to deploy the reverser. The actuators are linked together by a synchronizing system.

REVERSER CONTROL

Basically the thrust reverser system is controlled through the EEC from the two reverser latching levers located on the throttle control levers. The HCU has an isolation valve and a directional valve to select deploy or stow mode. The directional valve is operated to deploy only. For third defense line purposes, the Spoiler Elevator Computers (SECs) have previously opened the SOV and the hydraulic pressure is supplied to the HCU. Then, the Engine Interface Unit (EIU) permits reverser deployment by energizing of the inhibition relay, so the directional valve can be opened by the EEC. To command the thrust reverser, the EEC needs an "aircraft on ground" signal supplied by the Landing Gear Control and Interface Units (LGCIUs).

REVERSER INDICATING

The actual state of the thrust reverser is shown on the upper ECAM, REV indication appears in the middle of the Engine Pressure Ratio (EPR) dial. The signals come from the lock sensor and the Linear Variable Differential Transducer (LVDT).



HYDRAULIC SUPPLY ... REVERSER INDICATING

UGB13131 - U7ST0M0 - UM78P1IAE000002

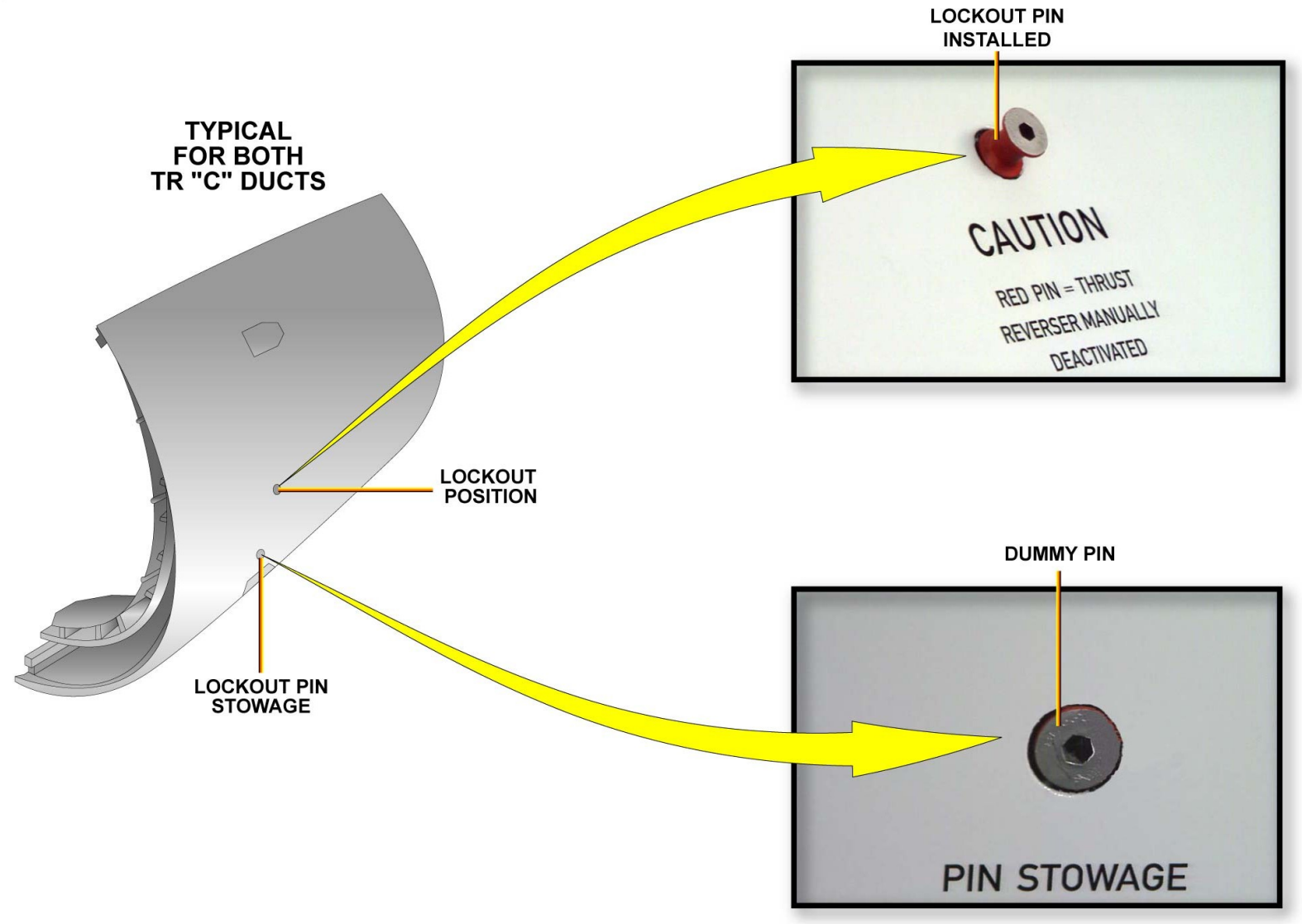
THRUST REVERSER SYSTEM PRESENTATION (2)

MAINTENANCE PRACTICES

To help trouble shooting, a reverser test can be performed through the MCDU. For maintenance purposes or to increase aircraft dispatch, the HCU is fitted with a manual deactivation lever to inhibit the thrust reverser system. In case of an inoperative thrust reverser, lockout pins stowed on the translating sleeves have to be installed to complete the deactivation procedure.

WARNING: THE THRUST REVERSER SYSTEM SHOULD BE INHIBITED USING THE HCU DEACTIVATION LEVER BEFORE WORKING ON THE SYSTEM OR ON THE ENGINE. THE SYSTEM MUST BE DEACTIVATED IN ORDER TO PREVENT THE THRUST REVERSER FROM OPERATING ACCIDENTALLY AND CAUSE SERIOUS INJURIES TO PERSONNEL AND/OR DAMAGE TO THE REVERSER.

UGB13131 - U7ST0M0 - UM78P11AE000002



MAINTENANCE PRACTICES

THRUST REVERSER MANAGEMENT (3)

GENERAL

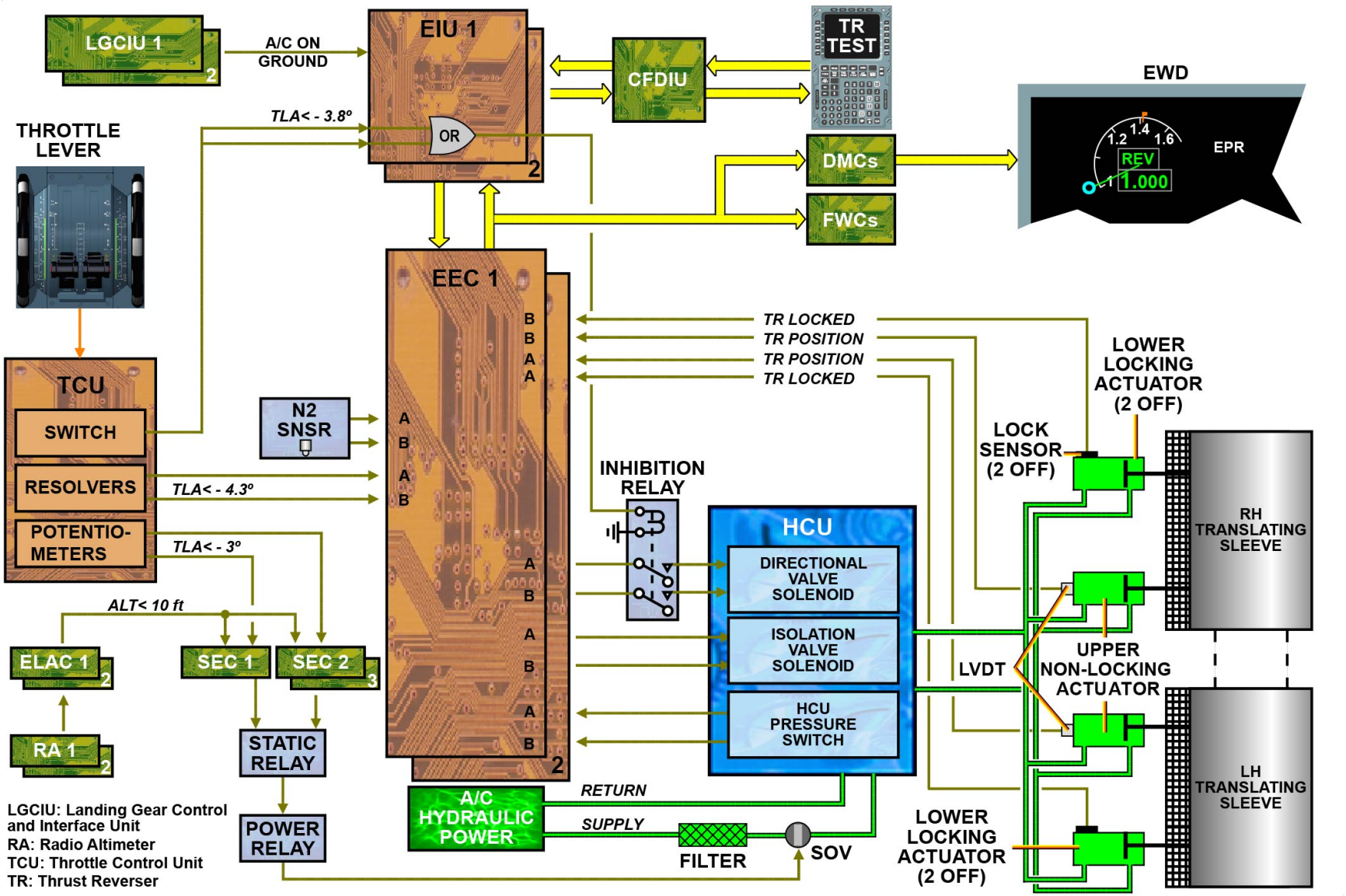
The thrust reverser system is controlled independently for each engine by the associated Full Authority Digital Engine Control (FADEC) system.

THRUST REVERSER ACTUATION

The hydraulic power required for the actuators is supplied by the normal aircraft hydraulic system:
- Green system for engine 1,
- Yellow system for engine 2.

A Shut-Off Valve (SOV) located upstream of the Hydraulic Control Unit (HCU) make up an independent locking system. Each channel of the Electronic Engine Control (EEC) controls and monitors solenoid valves included in the HCU, which provides the deployment and stowage of two translating sleeves.
Internal locks in the lower actuators are hydraulically operated. The operation of the actuators is synchronized by flexible drive shafts inside the deploy hydraulic lines, i.e. the synchronizing system.
The HCU includes an isolation valve, a pressure switch and a directional valve, which is controlled through the inhibition relay.

UGB13131 - U7ST0M0 - UM78D11AE000002



GENERAL & THRUST REVERSER ACTUATION

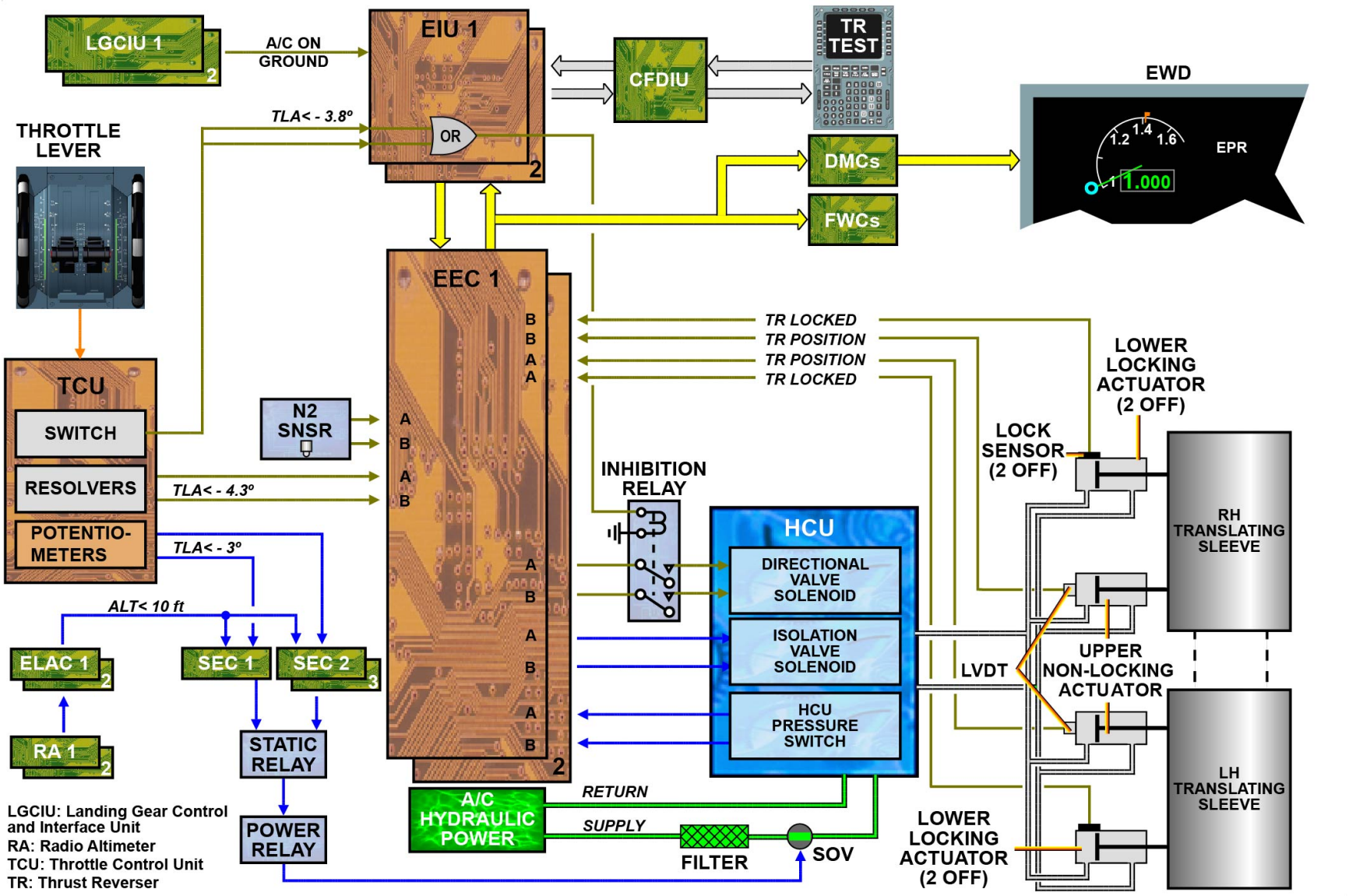
UGB13131 - U7ST0M0 - UM78D11AE000002

THRUST REVERSER MANAGEMENT (3)

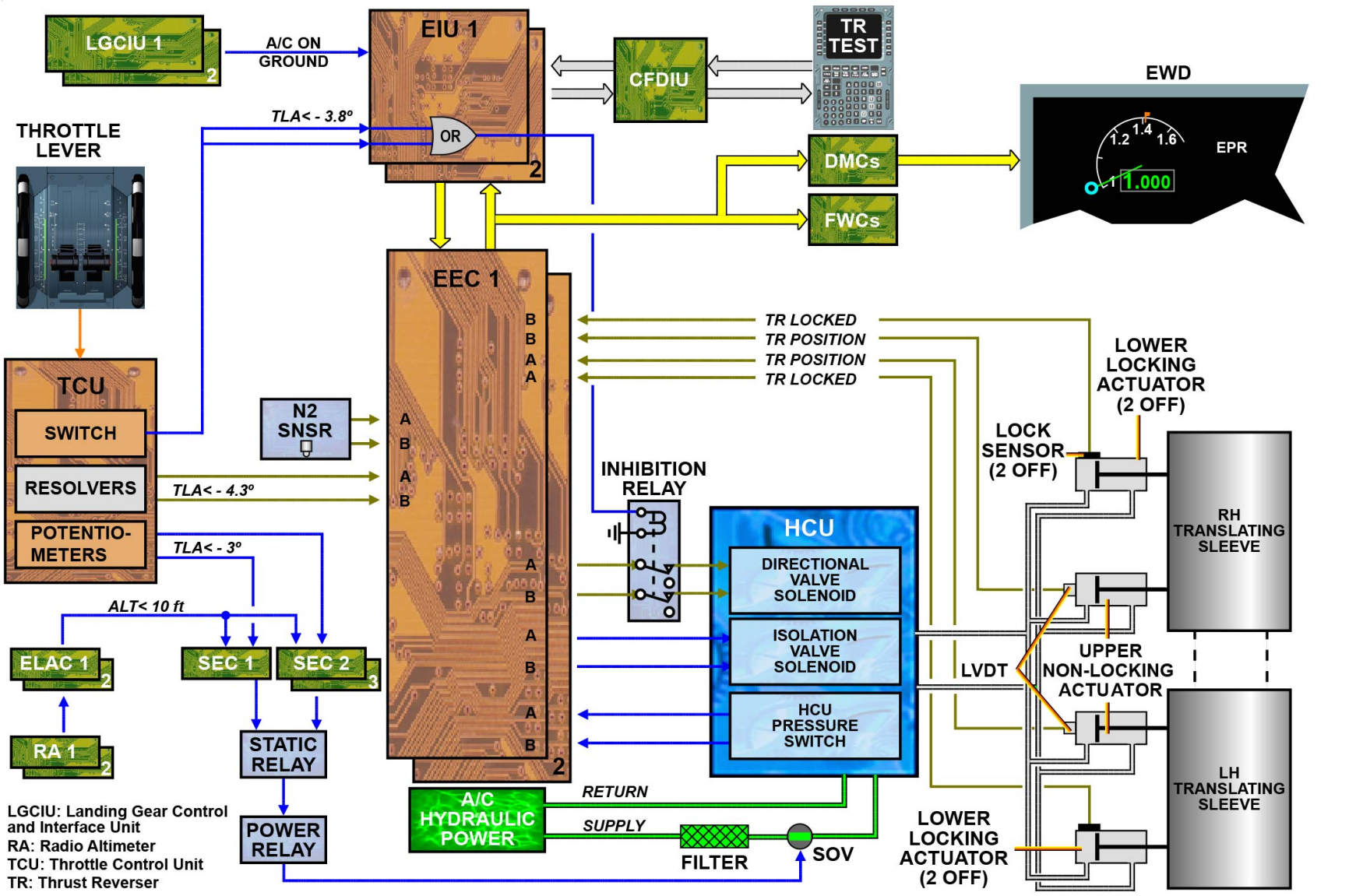
THRUST REVERSER CONTROL

When the reverse thrust is selected in the cockpit, the following sequence occurs:
- when the potentiometers detect a Throttle Lever Angle (TLA) lower than -3°, the SOV opens if the altitude is less than 10 ft and if high forward thrust, i.e. TLA < 30°, is not selected on the opposite engine. Then the HCU is supplied hydraulically. The SOV is controlled energized open by the Spoiler Elevator Computers (SECs) through the static and power relays.
- when the aircraft on ground signals from LGCIU and TLA reverse signal from TCU are sent to EIU, the EIU energize the inhibition relay.

UGB13131 - U7ST0M0 - UM78D11AE000002



THRUST REVERSER CONTROL



THRUST REVERSER CONTROL

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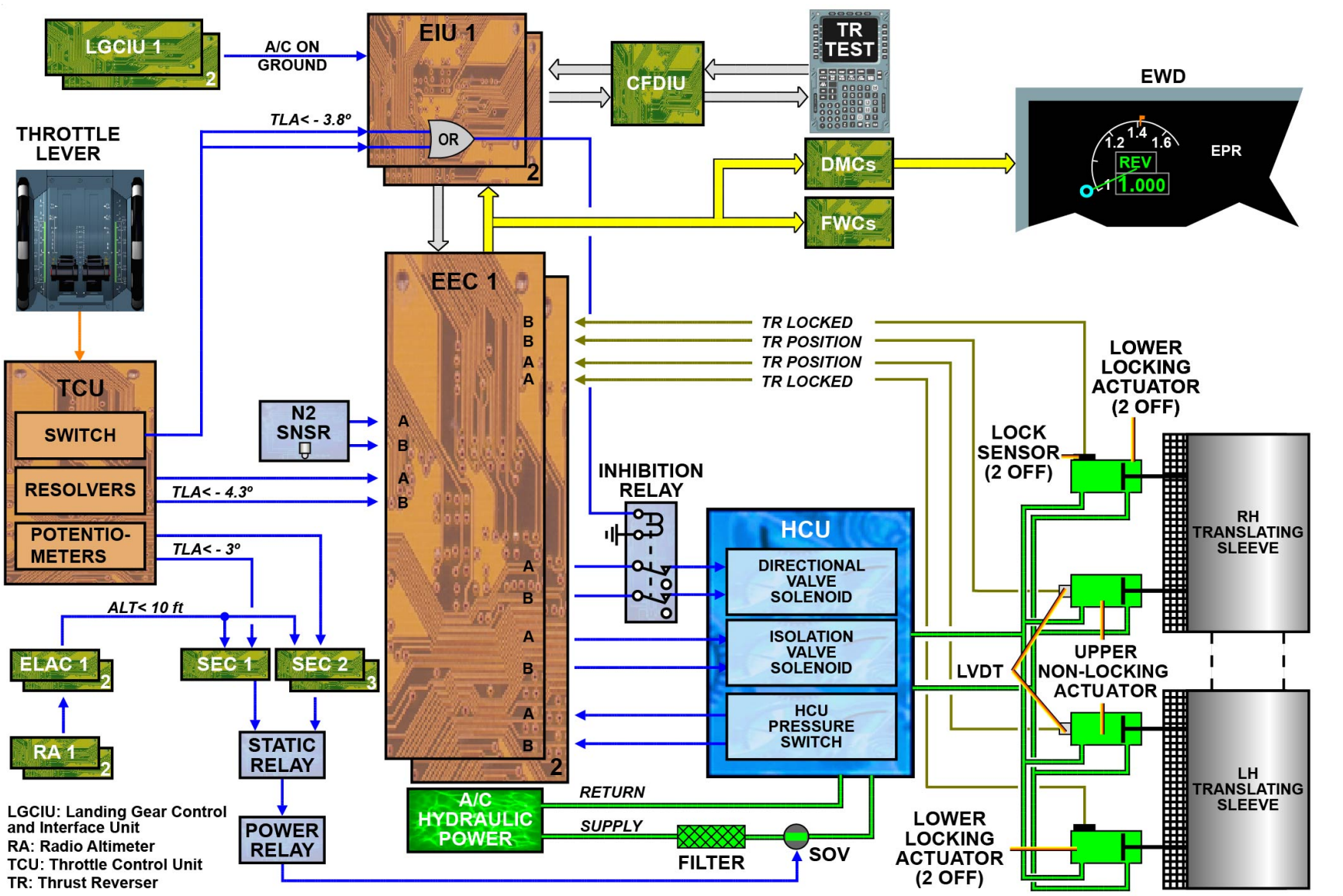
THRUST REVERSER MANAGEMENT (3)

THRUST REVERSER INDICATION

When the aircraft is on ground with the engine running, i.e. in N2 condition, and the resolvers detect a TLA lower than -4.3°, the EEC controls the thrust reverser operation through the HCU. The lock sensors and the Linear Variable Differential Transducers (LVDTs) are used to monitor the thrust reverser position and for EEC control.
The thrust reverser operating sequences are displayed in the cockpit on the EWD. An amber REVerse indication appears when the translating sleeves are in transit and then becomes green when the sleeves are deployed.

UGB13131 - U7ST0M0 - UM78D11AE000002



THRUST REVERSER INDICATION

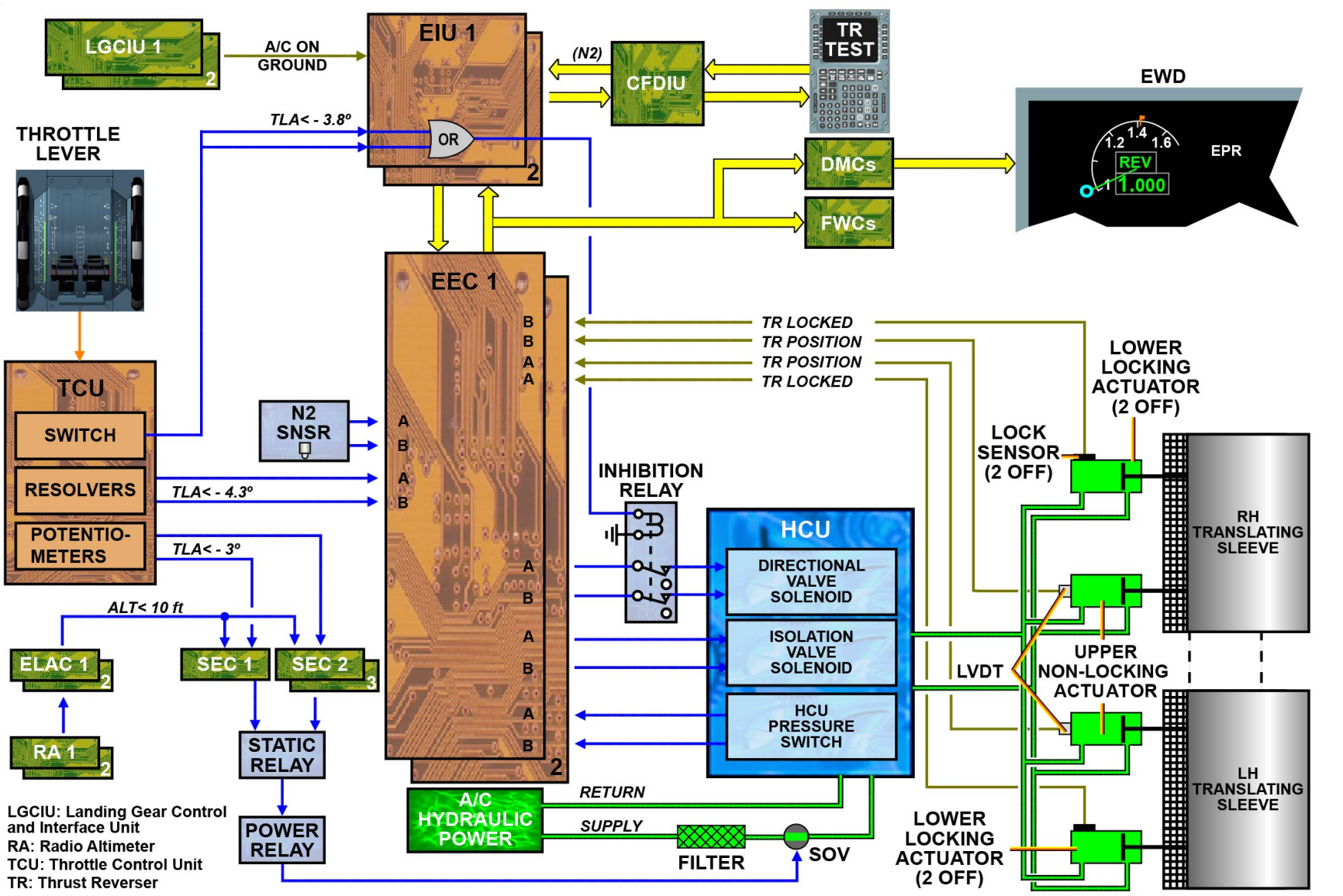
UGB13131 - U7ST0M0 - UM78D11AE000002

THRUST REVERSER MANAGEMENT (3)

CFDS INTERFACE

The Centralized Fault Display System (CFDS) operates in interface with the EIU to supply thrust reverser fault diagnostics. During maintenance, a thrust reverser test can be done through the MCDU menus. During this test, the Centralized Fault Display Unit (CFDIU) simulates the operation of an engine, i.e. the N2 condition, to let the thrust reverser deploy.

NOTE: If there is a mechanical inhibition of the thrust reverser (for dispatch), a caution "ENG X REV INHIBITED" is displayed on the ECAM to tell the crew that the thrust reverser is inoperative.



CFDS INTERFACE

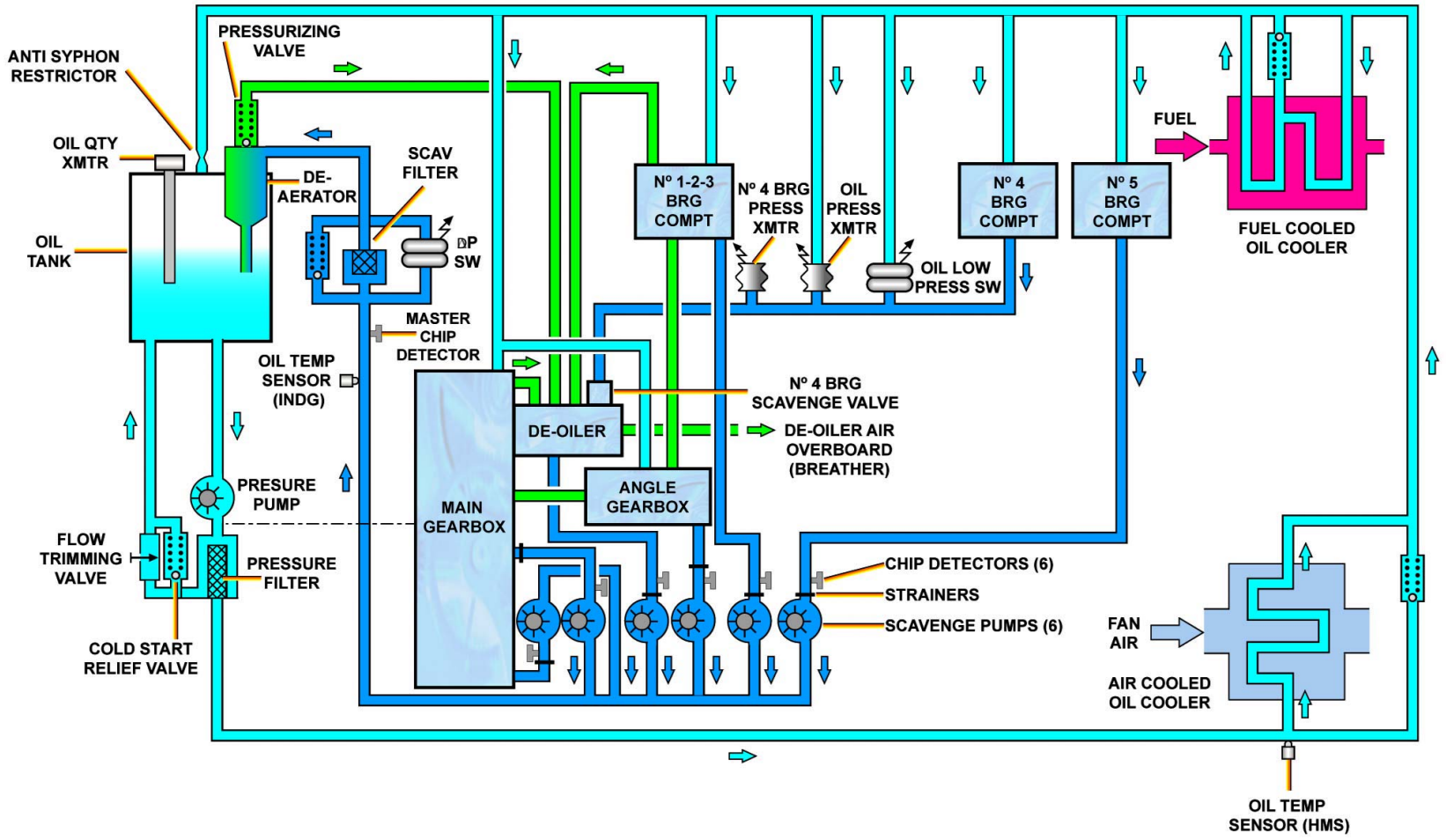
OIL SYSTEM D/O (3)

GENERAL

The engine oil system includes 3 circuits:
- a supply circuit,
- a scavenge circuit,
- a vent circuit.

The oil system lubricates and cools the bearings in the 3 bearing compartments. It also lubricates bearings and gears in the Angle Gearbox (AGB) and Main Gearbox (MGB). Oil cooling is controlled by a dedicated heat management system, which makes sure that engine oil, Integrated Drive Generator (IDG) oil and fuel temperatures are maintained within limits. The oil system is a dry sump full flow type system. The single pressure pump is independent of the 6 scavenge pumps (standard gear type). The 6 scavenge pumps are mounted on the MGB. The major components of the oil system are: oil tank, pressure and scavenge pumps, Fuel Cooled Oil Cooler (FCOC) and Air Cooled Oil Cooler (ACOC). Other components are a pressure filter included in the pressure pump, a scavenge filter, a de-oiler, a scavenge valve, chip detectors and sensors.

UGB13131 - U7ST0M0 - UM79D11AE000002


PRESSURIZING VALVE
ANTI SYPHON RESTRICTOR
OIL QTY XMTR
DE-AERATOR
SCAV FILTER
OIL TANK
DP SW
MASTER CHIP DETECTOR
OIL TEMP SENSOR (INDG)
Nº 1-2-3 BRG COMPT
Nº 4 BRG PRESS XMTR
OIL PRESS XMTR
OIL LOW PRESS SW
Nº 4 BRG COMPT
Nº 5 BRG COMPT
FUEL
FUEL COOLED OIL COOLER
Nº 4 BRG SCAVENGE VALVE
DE-OILER
DE-OILER AIR OVERBOARD (BREATHER)
ANGLE GEARBOX
MAIN GEARBOX
PRESURE PUMP
FLOW TRIMMING VALVE
PRESSURE FILTER
COLD START RELIEF VALVE
CHIP DETECTORS (6)
STRAINERS
SCAVENGE PUMPS (6)
FAN AIR
AIR COOLED OIL COOLER
OIL TEMP SENSOR (HMS)

GENERAL

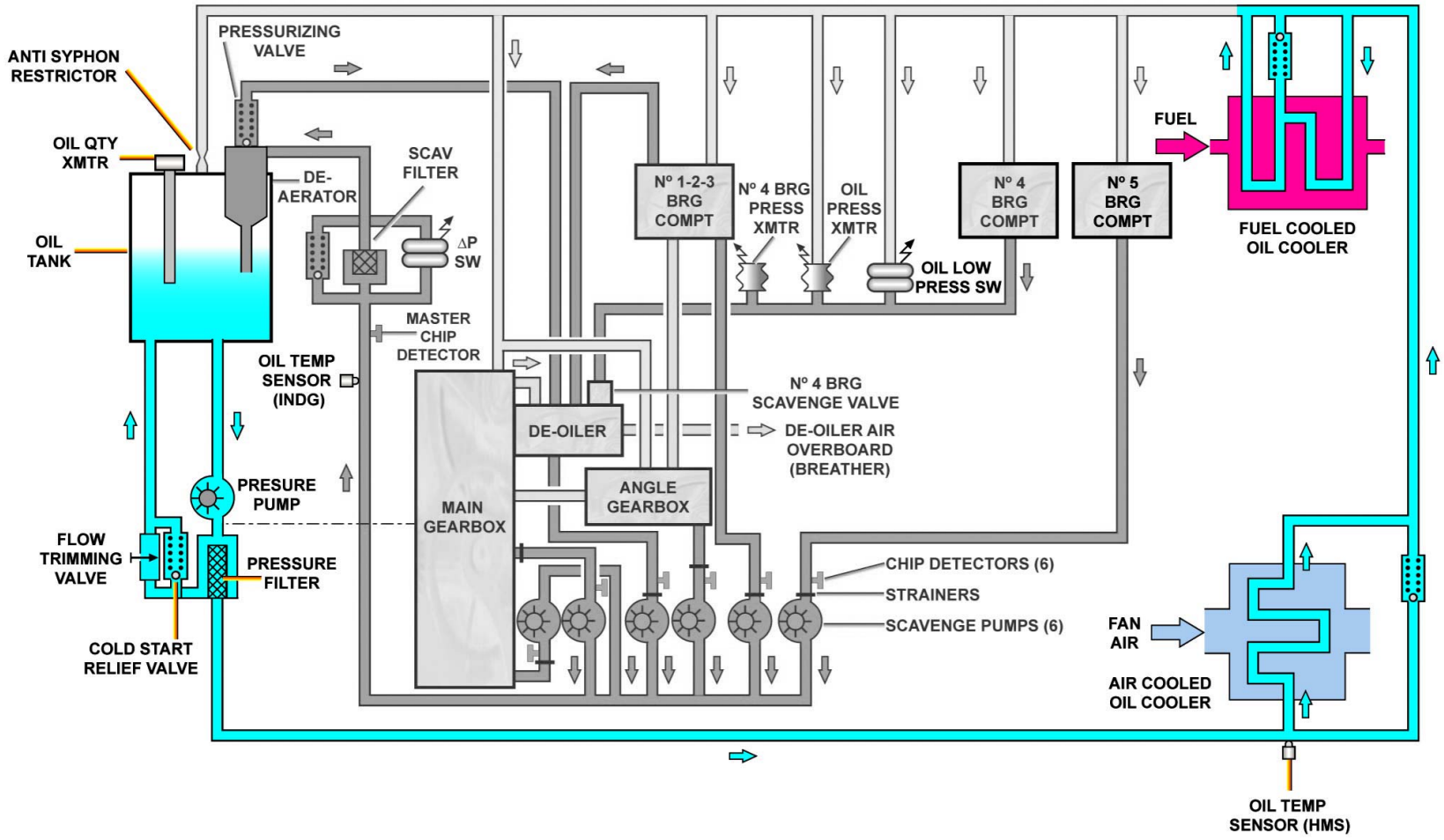
OIL SYSTEM D/O (3)

OIL SUPPLY CIRCUIT

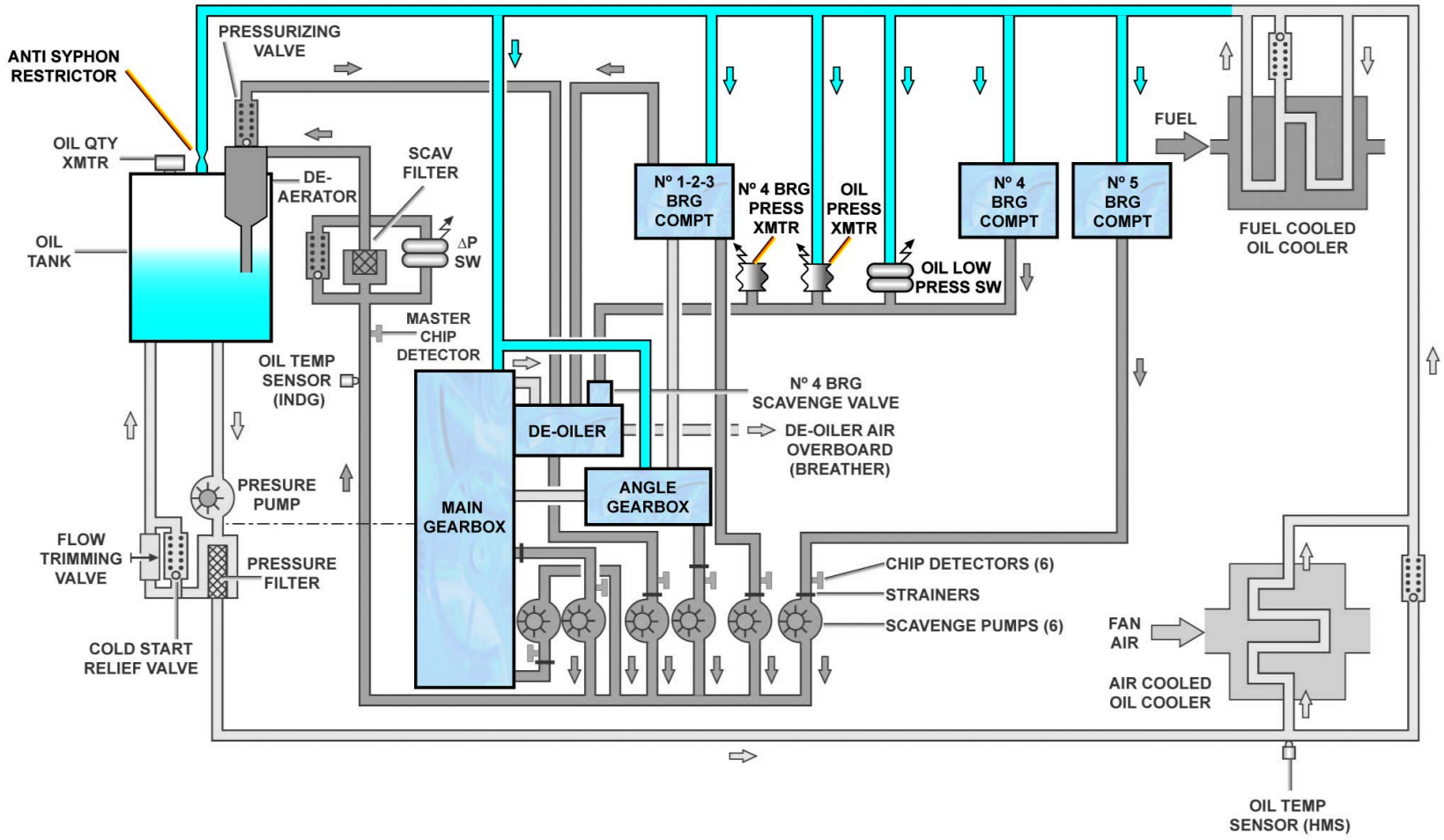
The oil from the tank goes through the pressure pump, then the pressure filter, then through the Air Cooled Oil Cooler (ACOC), then through the Fuel Cooled Oil Cooler (FCOC).
The oil temperature sensor is installed upstream of the Air Cooled Oil Cooler (ACOC) heat exchanger. This sensor is used for the heat management system, as controlled by the EEC
There is no pressure regulator, so the oil pressure varies with N2.
A pressure relief valve is used to limit the pressure during cold starts.
The cold start pressure relief valve opens at 450 PSI.
The pressurized oil that is filtered and then cooled by the Heat Exchangers according to the HMS control, is routed to each of the 3 bearing compartments, to the Angle gearbox and also the Main gearbox.
The oil supply has:
- an Low Oil Pressure (LOP) switch ,
- an Oil Pressure transmitter,

These sensors are used for the ECAM indication and monitoring.
The oil supply to the oil tank through the Anti Siphon Restrictor is used to clean the oil sight glass.

UGB13131 - U7ST0M0 - UM79D11AE000002



OIL SUPPLY CIRCUIT



OIL SUPPLY CIRCUIT

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OIL SYSTEM D/O (3)

OIL SCAVENGE CIRCUIT

Six scavenge pumps suck the oil from bearing compartments, and gearboxes. The pumps then return this oil to the tank through the scavenge filter.
The oil tank content is measured by an oil quantity transmitter.
The main scavenge line has:
- a master chip detector for inspection,
- an oil temperature sensor for indication,
- an oil differential pressure switch which is used for monitoring and warning to the cockpit when the scavenge filter is clogged.

If the scavenge filter becomes clogged a differential pressure switch sends a signal to the ECAM and eventually the by-pass valve will open. The ECAM is activated when the differential pressure is greater than 12 PSI. The by-pass valve opens at 20 PSI.

NOTE: The scavenge line of the No. 4 bearing compartment is controlled by the No. 4 bearing scavenge valve. Each scavenge line has a strainer and a magnetic chip detector to protect the pumps.

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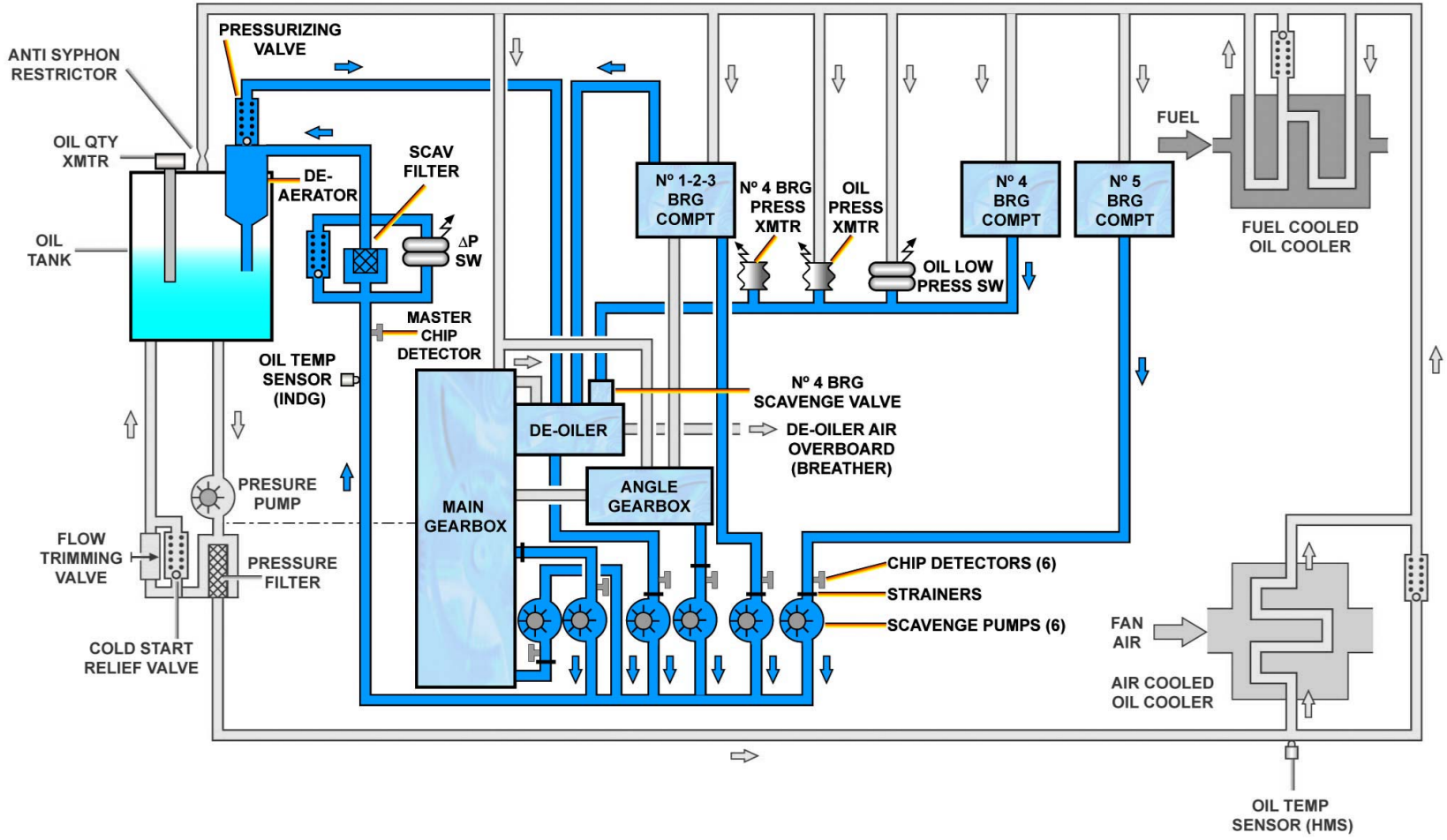

OIL SCAVENGE CIRCUIT

OIL SYSTEM D/O (3)

VENT CIRCUIT & NO.4 BEARING SCAVENGE VALVE

Air drawn in with the scavenge oil is separated in the tank by a de-aerator and is vented to a de-oiler. The No.4 bearing scavenge line is connected to the de-oiler through the scavenge valve. The de-oiler separates the oil still in the air and discharges this air overboard. Oil and air from the No.4 bearing compartment is scavenged through a common line. A pressure transducer, installed on this line, monitors the No.4 bearing scavenge pressure. The No.4 bearing scavenge valve maintains the compartment differential pressure to make sure that the sealing is adequate.
The No.4 bearing scavenge valve maintains No.4 bearing compartment seal differential-pressure by controlling the venting of the de-oiler compartment air/oil mixture. It is a pneumatically operated two-position valve, which uses stage 10-compressor air pressure as servo air. The valve is fully open at low engine speeds and closed to minimum-flow position at high engine speeds.

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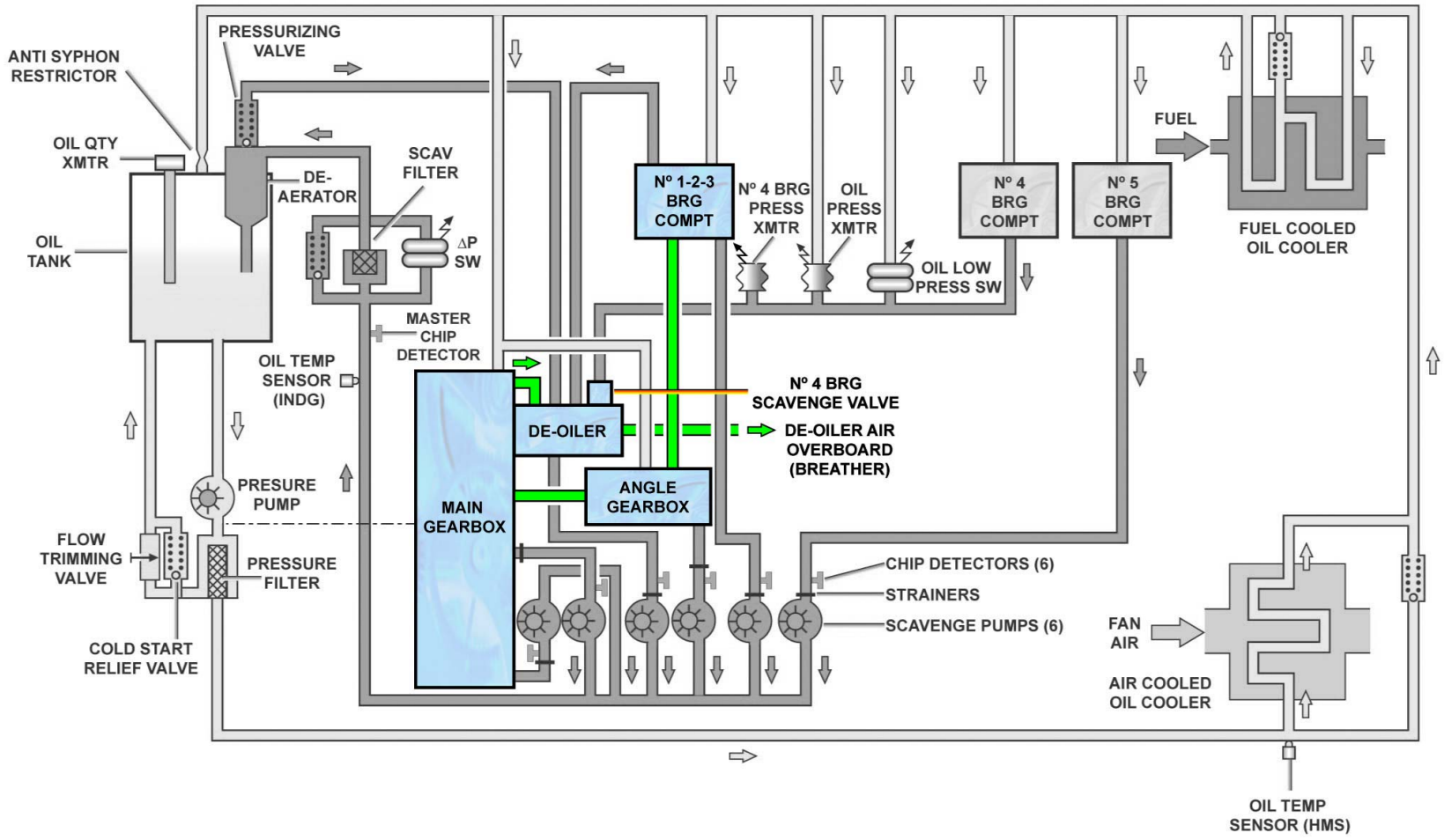

VENT CIRCUIT & NO.4 BEARING SCAVENGE VALVE

OIL SYSTEM D/O (3)

ELECTRICAL SENSORS AND TRANSMITTERS

The Oil QTY transmitter analog signal is sent to the SDAC 1 and SDAC 2 and to the related EIU and FWC .The digital signal is received by the DMC's that process the parameter for indication on the ECAM .
Normal quantity is indicated in green on the ECAM, flashing green in Advisory mode if oil quantity is lower than 5 Quarts.
The Oil TEMP (ACOC) sensor located upstream of the Heat Exchangers is used for HMS (Heat management System). The HMS shall calculate the need for oil cooling by the fuel only or by fuel supplemented by the air/oil heat exchanger. Such oil temp analog signal is sent to the related EEC for the Fuel Diverter and Return valve control.
The Oil LOW PRESSURE switch sends its discrete signal to the FWC to trigger the LOP warning, when the pressure drops below 60 PSI. The signal is also sends to the EIU to elaborate the Low Oil Pressure on Ground output discrete.
The Oil PRESSURE transmitter analog signal is sent to the SDAC 1 and SDAC 2 and to the related EIU and FWC .The digital signal is received by the DMC's that process the parameter for indication on ECAM. Normal pressure is indicated green on the ECAM, flashing green in Advisory mode if oil pressure gets too high (390 °C increasing or 386 °C decreasing). If the oil pressure gets below 80 PSI the indication becomes amber and red if the pressure drops below 60 PSI.
The N°4 BRG pressure transmitter analog signal is sent via the related EIU to the FWC to trigger the N 4 BRG SCAV VALVE warning.
The Oil TEMP Scavenge sensor analog signal is sent to the related EIU and FWC, and is used for indication on the ECAM. Normal temperature is indicated green on ECAM, flashing green in Advisory mode if oil temperature gets too high (> 157 °C) , or steady amber if over temperature condition of 157 °C lasts more than 15 minutes. The indication becomes amber and a high oil temperature warning is triggered, if the oil temperature reaches 165 °C.

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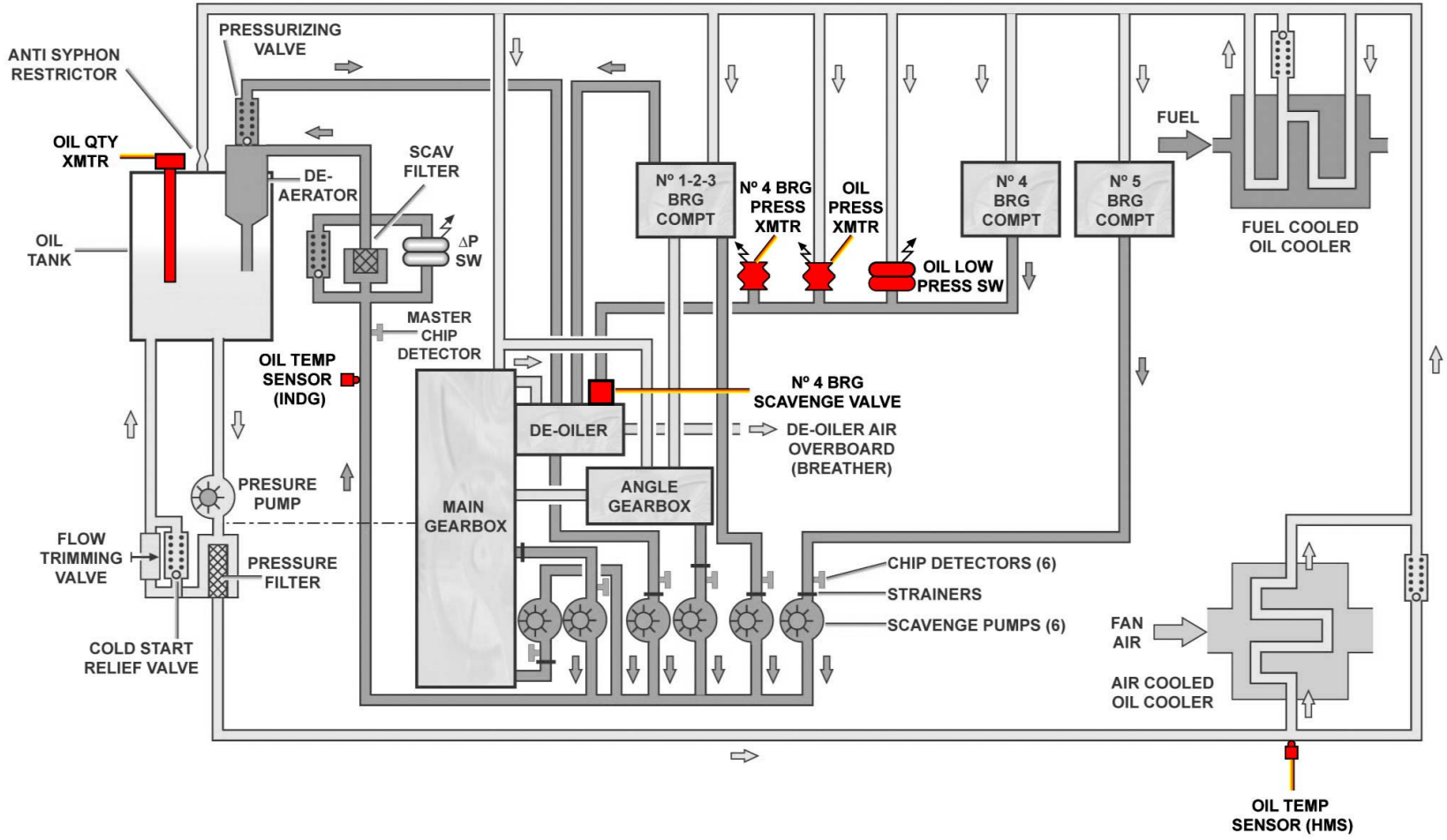

ELECTRICAL SENSORS AND TRANSMITTERS

OIL SYSTEM D/O (3)

NO. 4 BEARING

Oil and vent air from the No. 4 bearing compartment is scavenged through a common line. This dual-purpose line is piped through the two-position No. 4 bearing scavenge valve (and then continues to the deoiler).
The two-position scavenge valve opens to the maximum flow area at low power to maximum scavenging. At high power this valve closes to the minimum area to maintain the seal pressure differentials and reduce overboard loss of vent air.
The valve operates in the following manner.
There are two basic operating positions, low power and high power. In the low-power position, where the compressor 10th stage pressure (P10) is less than 150 PSI, the valve is held spring loaded in the fully open position. The bearing compartment scavenge flow goes through the valve, restricted only by the porting in the valve seat.
As the engine power increases, the P10 pressure rises. When this pressure exceeds 150 psi, the valve moves away from the max flow stop. This is due to the pressure acting on the differential areas of the valve and overcoming the spring load. The valve moves towards the min flow or high power setting. As the valve moves towards the peripheral ports in the seat, totally closing these ports, the flow through the valve is now restricted to one central port in the valve seat. Full travel is achieved at P10 pressure of approximately 210 psi.
As the valve moves away from the max flow stop, the influence of the magnets on the reed switch decreases and the reed switch opens. The circuit is broken, indicating that the valve has moved.
As the engine power decreases, the spring load overcomes the decreasing P10 pressure. The valve moves towards the max flow or low power position, uncovering the ports in the valve seat and restoring maximum flow through the valve. As the valve approaches the maximum flow stop, the influence of the magnets on the reed switch increases.
The reed switch closes, completing the circuit and indicating the valve position.

The function of the No.4 bearing indicating system is to monitor the correct operation of the No.4 bearing 2-position scavenge valve and to detect a No.4 bearing carbon-seal failure.
The No.4 bearing pressure transducer is installed on the right side of the deoiler and senses pressure at the No.4 bearing outlet line.
The position indicator is integral with the No.4 bearing scavenge valve which is located in the No.4 bearing compartment scavenge line.
At engine low power, the valve is open and the switch closes sending a ground signal. At engine high power, the valve closes and the switch opens.
The EIU has two logics, allowing the monitoring of the No 4 Bearing Scavenge Valve operation as well as the No. 4 bearing carbon seal failure.

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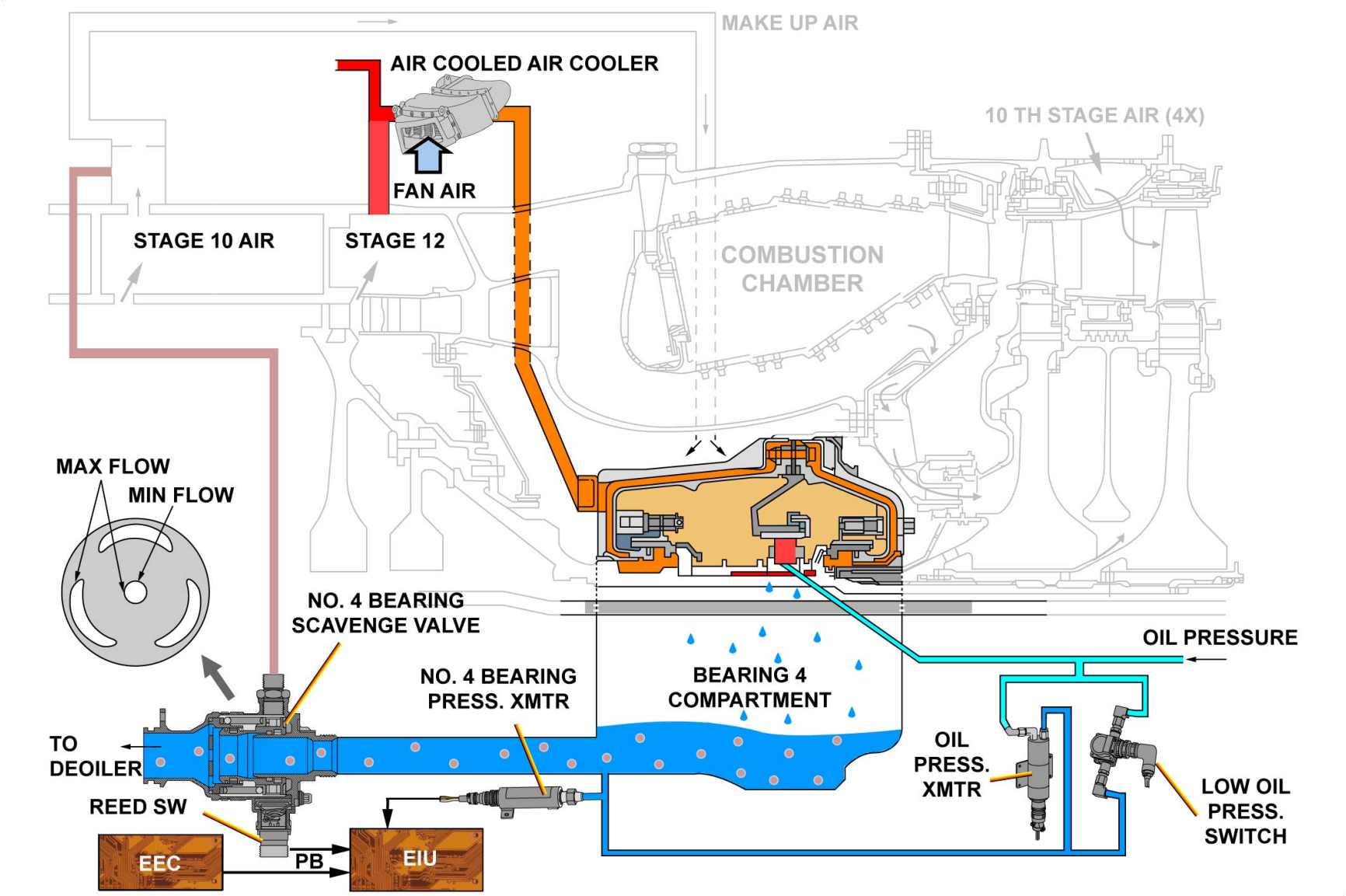
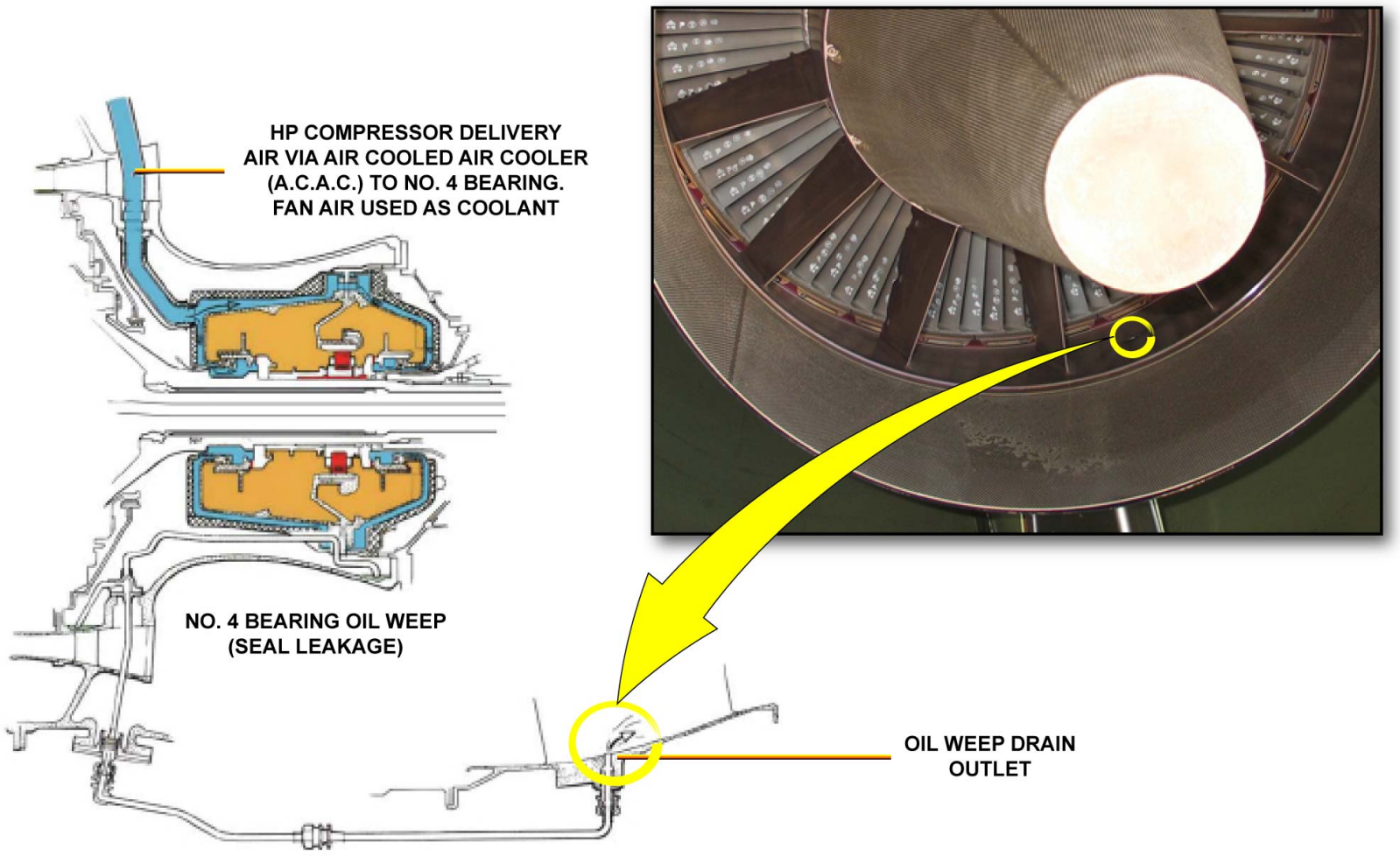

MAKE UP AIR
AIR COOLED AIR COOLER
FAN AIR
10 TH STAGE AIR (4X)
STAGE 10 AIR
STAGE 12
COMBUSTION CHAMBER
MAX FLOW
MIN FLOW
NO. 4 BEARING SCAVENGE VALVE
NO. 4 BEARING PRESS. XMTR
BEARING 4 COMPARTMENT
OIL PRESSURE
TO DEOILER
REED SW
EEC
PB
EIU
OIL PRESS. XMTR
LOW OIL PRESS. SWITCH

NO. 4 BEARING


HP COMPRESSOR DELIVERY
AIR VIA AIR COOLED AIR COOLER
(A.C.A.C.) TO NO. 4 BEARING.
FAN AIR USED AS COOLANT
NO. 4 BEARING OIL WEEP
(SEAL LEAKAGE)
OIL WEEP DRAIN
OUTLET

NO. 4 BEARING

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ENGINE SYSTEM OPERATION, CONTROL & INDICATING (IAE V2500) (3)

FADEC POWERING / ENGINE CONTROLS

N1 MODE RATED

ENG 1 + 2 EPR MODE FAULT - N1 UNRATED

ENG 1 HP FUEL VALVE FAULT

ENG 1 EIU FAULT

ENG 1 OIL FILTER CLOG

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OPENING & CLOSING OF ENGINE COWL DOORS (2)

FAN AND THRUST REVERSER COWL DOORS OPENING

WARNING: DO NOT OPEN THE FAN COWL DOORS IF THE WIND SPEED IS MORE THAN 60 MPH (96 KM/H). BE CAREFUL IF YOU OPEN THE FAN COWL DOORS IF THE WIND SPEED IS MORE THAN 30 MPH (48 KM/H), INJURY OR DAMAGE TO THE ENGINE CAN OCCUR IF THE WIND MOVES THE FAN COWL DOORS. MAKE SURE THAT THE HOLD OPEN RODS OF THE FAN COWL DOORS ARE IN THE EXTENDED POSITION AND ARE ATTACHED CORRECTLY. IF NOT, THE COWL DOORS CAN CLOSE ACCIDENTALLY.

WARNING: MAKE SURE THAT THE TAKE-UP DEVICE IS CORRECTLY ENGAGED BEFORE YOU RELEASE THE LATCHES. FAILURE TO DO SO CAN CAUSE THE LATCHES TO OPEN FAST AND CAUSE INJURY TO PERSONS.

CAUTION: Do not open the inboard thrust reverser "C" duct if the wing leading edge slats are extended. Damage to the thrust reverser, wing leading edge slats and wing can occur.

FAN COWL DOORS OPENING

Before working on the engine, safety Precautions have to be taken in the Cockpit.
On Panel 115 VU, put a warning notice to tell people not to start the Engines.
On the Overhead Panel, on panel 50 VU, make sure that the ON legend from the FADEC Ground Power switch is OFF and install a warning notice.

CAUTION: Caution: Do not attempt to open the fan Cowl doors if the wind speed is higher than 96 Km/h (60MPH).
Release the four latches starting from the front to the rear.
Push the latch snapper and pull the latch handle.
Lift and support the door by hand.
Release one of the hold open rods from the stowing bracket on the cowl door.
Disengage the lock arm and move the release collar towards the permanently attached end of the rod.
The word UNLOCKED can be seen when the release collar is not in the locked position.
Extend the inner part of the hold open rod and let the release collar and its lock arm go to their locked position.
The word UNLOCKED doesn't show again.
Put the push-lock into the hole on the attach point bracket.
Repeat this procedure for each all hold open rod.

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FAN AND THRUST REVERSER COWL DOORS OPENING - FAN COWL DOORS OPENING

OPENING & CLOSING OF ENGINE COWL DOORS (2)

FAN AND THRUST REVERSER COWL DOORS OPENING (continued)

THRUST REVERSER COWL DOORS OPENING

Before you start work, make sure you follow all the safety precautions as outlined in the Aircraft Maintenance Manual.
Put a warning notice on the center pedestal to tell people not to start the engine.
In the same way put a warning notice on the overhead maintenance panel to make sure that the FADEC Ground Power pushbutton stays in the off position.
Open the fan cowl doors.
Gain access to the hydraulic control unit lever and de-activate the thrust reverser system.
Now open the thrust reverser pressure relief doors on the bottom of the nacelle.
Remove the auxiliary latch assembly from its retention clip on the left hand thrust reverser half and make sure that the latch is adjusted to its minimum length before engaging the auxiliary latch assembly in the hook on the right hand thrust reverser half.
Turn the body of the auxiliary latch assembly with a spanner to pull the thrust reverser halves closer together and to relieve the tension on the latches.
Once the tension is relieved release the five latches in the following order according to the Aircraft Maintenance Manual. The latches are counted from forward to aft. They are released in the following order: 3 - 2 - 5 and then 6 - 4 - 1.
- Begin with the latch in position number 3, the middle bifurcation latch,
- continue with latch number 2, the forward bifurcation latch,
- release the translating sleeve double latch in positions 5 and 6,
- then the aft bifurcation latch, number 4,
- finally release the V-groove latch in position number 1, which will make the red flag of the hold open device appear.

Turn the auxiliary latch assembly to make it longer and disengage it from the hook on the right hand thrust reverser half.
Then stow the auxiliary latch assembly into its retention clip.
Before opening the thrust reverser cowl doors make certain that the slats are retracted and the translating sleeves stowed.
The thrust reverser cowl doors are opened using a hydraulic hand pump. Make sure the hand pump reservoir is filled with the correct type of oil.
Remove the protection cap and connect the hose of the hand pump to the quick-disconnect on the thrust reverser half.
Close the valve on the hand pump.
Now operate the hand pump until the thrust reverser half is fully open
The thrust reverser half is held open by two hold open rods stowed inside the thrust reverser half:
Open the clip assembly to release the aft hold-open rod.
Push the lock arm and fully extend the hold open rod until it locks in the fully extended position.
While the rod plunger is held close to the anchorage bracket on the engine, the valve on the hand pump is slowly opened until the plunger engages.
Close the valve on the hand pump again.
Release the forward hold open rod from its clip assembly and hold it in position in its bracket on the engine.
Open the valve on the hand pump so that the plunger of the forward hold open rod engages.
Now the weight of the thrust reverser half is equally carried by the two hold open rods.
The second half is opened in the same way. Once all doors are opened, the engine is accessible for maintenance operations.

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FAN AND THRUST REVERSER COWL DOORS OPENING - THRUST REVERSER COWL DOORS OPENING

OPENING & CLOSING OF ENGINE COWL DOORS (2)

FAN AND THRUST REVERSER COWL DOORS CLOSING

CAUTION: Make sure that the engine area is clear of tools and equipment before closing the fan cowl doors.

THRUST REVERSER COWL DOORS CLOSING

After removal of the opening actuator manifold connector protection cap, connect the flexible hose of the Hand Pump to the opening actuator manifold connector on the thrust reverser half.
Make sure the hydrl. Hand pump reservoir is filled with the correct type of oil.
Operate the hand pump to open the thrust reverser half, to remove the load from the hold open rods.
Disengage the hold open rods from the rod anchorage brackets and apply pressure to the spring-loaded lock that is marked "PUSH".
Retract the coupler end of the rod and release the lock. Continue to retract the coupler until the lock engages in the front locking groove.
Stow both rods into their clips on the inside of the thrust reverser half and secure with the latches.
Open the valve on the hydraulic hand pump slowly and let the thrust reverser half close.

CAUTION: Do not disconnect the hand pump until the opening actuator system has been drained for a minimum of one minute after closing of the thrust reverser cowl. Compliance with this recommendation has proven to extend the thrust reverser cowl operating service life and to minimize leakage.

Remove the auxiliary latch assembly from its retention clip on the left hand thrust reverser half and make sure that the latch is adjusted to its minimum length before starting to engage the auxiliary latch assembly in the hook on the right hand thrust reverser half.
Turn the body of the auxiliary latch assembly with a spanner to pull the thrust reverser halves closer together.
Close the thrust reverser latches in sequence as outlined in the Aircraft Maintenance Manual:
- 1st V-Groove Latch,
- followed by aft bifurcation latch,
- the thrust reverser translating sleeve double latches,
- the forward bifurcation latch,
- and the middle bifurcation latch.

Turn the auxiliary latch assembly to make it longer and disengage it from the hook on the right hand thrust reverser half.
Then stow the auxiliary latch assembly into the retention clip.
Close the thrust reverser pressure relief doors
Disconnect the flexible hose of the hydraulic hand pump from the actuator manifold connector of the thrust reverser half and activate the thrust reverser hydraulic control unit.

UGB13131 - U7ST0M0 - UM70Y2IAE000002

FAN AND THRUST REVERSER COWL DOORS CLOSING - THRUST REVERSER COWL DOORS CLOSING

OPENING & CLOSING OF ENGINE COWL DOORS (2)

FAN AND THRUST REVERSER COWL DOORS CLOSING (continued)

FAN COWL DOORS CLOSING

Hold the cowl door.
Disengage the hold-open rod from its attach point bracket.
Disengage the lock-arm and move the release collar towards the permanently attached end of the rod.

NOTE: Note: The word unlocked can be seen when the release collar is not in the locked position.

Push the inner part of the rod fully into the outer part of the rod.
Put the push-lock into the stowing bracket.
Make sure that the push-lock assembly engages correctly and locks in the stowing bracket.
Lower the cowl door slowly.
Release the fan cowl doors from the hold-open device.
It can be easily seen that the fan cowl doors have been left unlatched.
The hold open device leaves at one each gap at three or nine o'clock.
Use a Phillips screwdriver to push the pin towards the door locator until the fan cowl doors are released.
Remove the screwdriver from between the fan cowl doors.
Start by closing the rear latch and then move forward.
Hold the fan cowl doors together and engage the spigots in their locating holes.
Start to close with a rear latch and move forward.
Clean the Area and remove the Safety Precaution signs.

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FAN AND THRUST REVERSER COWL DOORS CLOSING - FAN COWL DOORS CLOSING

THRUST REVERSER DEACTIVATION & LOCKOUT (2)

THRUST REVERSER DEACTIVATION AND LOCKOUT

WARNING: THE THRUST REVERSER SYSTEM SHOULD BE DEACTIVATED USING THE HYDRAULIC CONTROL UNIT (HCU) LEVER, BEFORE WORKING ON THE SYSTEM OR ON THE ENGINE. IF NOT THE THRUST REVERSER CAN ACCIDENTALLY OPERATE AND CAUSE SERIOUS INJURIES TO PERSONNEL AND/OR DAMAGE TO THE REVERSER.

This procedure is carried out when a fault occurs on a thrust reverser which can not be repaired for the next flight. Deactivation and lockout are therefore provided to secure the translating sleeves in stowed position when the aircraft has to be dispatched with an inoperative thrust reverser.
Before working on the engine safety precautions have to be taken in the cockpit.
On Panel 115 VU put a warning notice to tell people not to start the engines.
On the Overhead Panel, panel 50 VU, make sure that the on legend from the FADEC Ground Power switch is off and install a warning notice.
Open the fan cowl doors and put the access platform into position.
Deactivate the Thrust Reverser HCU by removing the quick release pin from the stowage position on the HCU. Move the inhibition lever to the OFF position and insert the quick release pin.
Make sure that the translating sleeves are in the fully retracted position. If not move them manually to the retracted position in accordance to the AMM procedure. The following deactivation procedure needs to be done on both translating sleeves of the related engine.
Remove the plug from the lockout assembly on the outside of the translating sleeve.
Remove the lockout pin from the stowage position on the outside of the translating sleeve.
Make sure that the lockout pin and the plug are cleaned and that anti seize material is applied to the threads of both components before you continue with the deactivation procedure.
Install the lockout pin in the lockout assembly of the translating sleeve.
Install the plug in the lockout pin stowage bracket assembly of the translating sleeve

NOTE: Note: For easy identification of a deactivated thrust reverser, the red colored lockout pin will stand out of the structure of the translating sleeve when installed in the lockout assembly.

Do an operational test of the thrust reverser system with the CFDS in accordance to the AMM.
Energize the related EEC with the FADEC Ground Power Pushbutton Switch on panel 50VU.
Get access to the CFDS System Report Test, select next page and select the line key next to engine.
Select the line key related to the FADEC 1A or 1B menu and activate the interactive test by selecting the line key next to System Test and Reverser Test.
Obey the cautions and warnings in the AMM and on the MCDU before you start the Reverser Test to prevent any injury to personnel or damage to equipment.
During the test make sure that the green or amber REV indication does not appear in the EPR indication on the engine and warning display.
Make sure that none of the following messages appeared on the test report after the test :
REV LVDT CHA/HC/EEC 1(2)
REV LVDT CHB/HC/EEC 1(2)
REV POS OR LVDT FAULT 1(2)
Exit the reverser test menu on the MCDU in accordance to the AMM procedure and bring the aircraft back to its initial configuration. Check that the ECAM warning ENG 1(or 2) Reverse Unlocked is not displayed.

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Make sure that the working area is clean and clear of tools. Remove the access platform and close the fan cowl doors.
Remove the warning notices in the cockpit.
In the cockpit install a warning notice to show that the thrust reverser is inoperative. Make an entry in the logbook.
This completes the Thrust Reverser deactivation procedure for flight operation.

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THRUST REVERSER DEACTIVATION AND LOCKOUT

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THRUST REVERSER DEACTIVATION & LOCKOUT (2)

THRUST REVERSER INHIBITION INDICATION

If there is a mechanical inhibition for dispatch, a caution "ENG X REV INHIBITED", activated through interactive mode, is displayed on the ECAM to tell the crew that the thrust reverser is inoperative.

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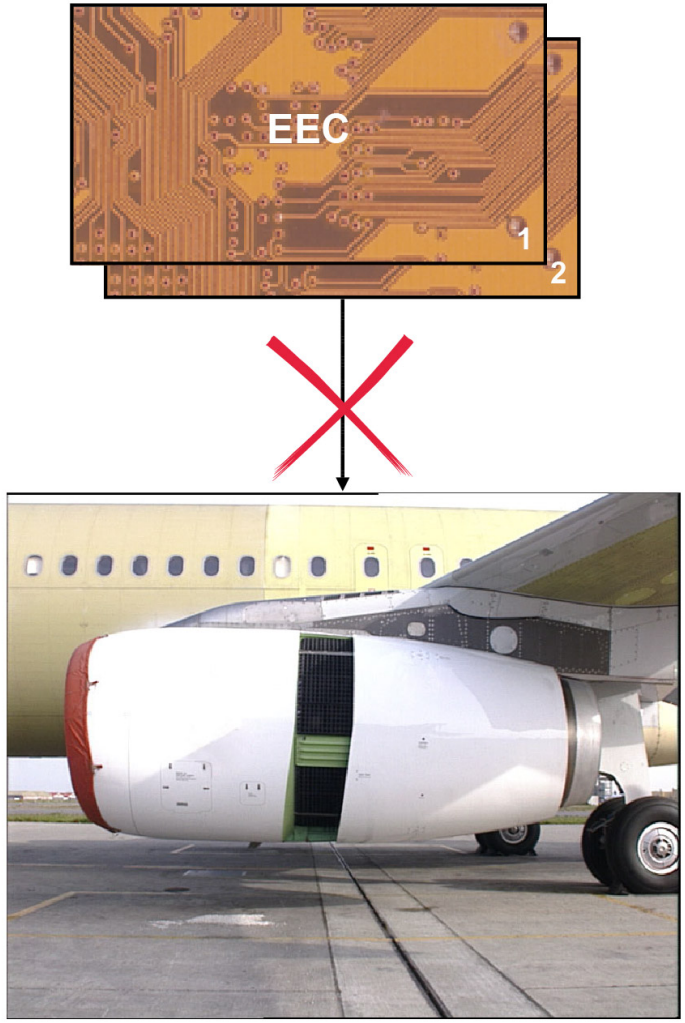
EWD



THRUST REVERSER DOORS

THRUST REVERSER INHIBITION INDICATION

MAINTENANCE OPERATIONS (2)

FAN COWL DOOR REMOVAL/Installation

WARNING: DO NOT OPEN THE FAN COWL DOOR(S) WHEN THE WIND SPEED IS 60 MPH (96 KPH) OR MORE. INJURY AND/OR DAMAGE TO THE ENGINE CAN OCCUR IF THE WIND MOVES THE FAN COWL DOOR(S).

REMOVAL

Make sure that the A/C is prepared for the removal task. First open the fan cowl door and install the hoisting sling. Disengage and store the hold-open rods. Lift the door with the hoist and gain access to the hinges. Remove the four hinge bolts and nuts. Make a note of the position of the bolts because they must be put at the same place during the installation. Finally remove and lift the door over to the transit stand.

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FAN COWL DOOR REMOVAL/INSTALLATION - REMOVAL

MAINTENANCE OPERATIONS (2)

FAN COWL DOOR REMOVAL/Installation (continued)

installation

We will now see a fan cowl door installation. First of all, prepare the A/C for maintenance tasks on the engine. On the transit stand attach the hoisting sling to the lower part of the fan cowl door and secure it. Then on the opposite side attach the sling to the upper hoisting points and secure it. Remove the fan cowl door from the fan cowl transit stand with the sling and the hoist and carefully install the door. Examine the fan cowl hinges and the pylon hinges and make sure that they are not damaged before aligning them. Install the bolts and nuts. Make sure that the bolts are installed in the same positions noted during removal. Deploy the hold-open rods and engage them on their attach brackets on the fan case. Finally remove the sling and return to the initial A/C configuration as defined in the close-up subtasks.

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FAN COWL DOOR REMOVAL/INSTALLATION - INSTALLATION

MAINTENANCE OPERATIONS (2)

THRUST REVERSER cowl Door REMOVAL/installation

WARNING: DO NOT GET HYDRAULIC FLUID ON YOUR SKIN, IN YOUR MOUTH OR IN YOUR EYES. HYDRAULIC FLUID IS POISONOUS AND CAN GO THROUGH YOUR SKIN AND INTO YOUR BODY. FLUSH HYDRAULIC FLUID FROM YOUR MOUTH OR YOUR EYES AND GET MEDICAL AID. BE CAREFUL DURING THE REMOVAL OR INSTALLATION OF THE THRUST REVERSER "C" DUCT, IT WEIGHS 580 LBS (263 KG).

CAUTION: Do not open or remove the thrust reverser "C" ducts if the wing leading edge slats are extended. This will cause damage to the thrust reverser, the wing leading edge slats and the wing.

WARNING: MAKE SURE THAT THE HYDRAULIC HAND PUMP HOSE IS CORRECTLY CONNECTED TO THE THRUST REVERSER "C" DUCT OPENING ACTUATOR, IF NOT THE THRUST REVERSER "C" DUCT CAN CLOSE QUICKLY AND CAUSE INJURY TO PERSONS BETWEEN THE THRUST REVERSER "C" DUCT AND THE ENGINE.
MAKE SURE THAT ALL THE TRAPPED AIR IS BLED FROM THE SYSTEM, IF NOT TRAPPED AIR WILL CAUSE AN IRREGULAR CLOSE RATE OF THE THRUST REVERSER "C" DUCT.

REMOVAL

First of all prepare the A/C for the removal task and deactivate the thrust reverser system. Install the thrust reverser sling to the sling points. First at the two lower hoisting points. Using the hoist hold up the weight of the thrust reverser cowl door, and after having removed the hinge access panel from the pylon, attach the last hoisting fixture to the thrust reverser hinge upper beam. Next, disconnect the hydraulic manifold from the thrust reverser cowl door opening actuator. Install the protective caps, and remove the actuator. On the thrust reverser system disconnect the electrical connector from the electrical receptacle, and disconnect the deploy and retract hoses from the upper actuator, then gain access to the pylon hinges and remove the four hinge bolts and nuts. Carefully lift and disengage the thrust reverser cowl door from the pylon hinges. Remove the cowl door taking care that it does not hit against the slat surfaces. Finally lower it onto its dolly.

THRUST REVERSER COWL DOOR REMOVAL/INSTALLATION - REMOVAL

MAINTENANCE OPERATIONS (2)

THRUST REVERSER cowl Door REMOVAL/installation (continued)

INSTALLATION

Make sure that the A/C is in same configuration as for the removal task with the thrust reverser system deactivated. On the dolly, attach the thrust reverser hoisting sling to the three sling points on the thrust reverser half. First, attach the sling to the hoisting fixture provided on the thrust reverser hinge upper beam. Then attach the sling to the lower hoisting points of the cowl door. Lift the cowl door from the dolly, and carefully position the cowl door onto the pylon. Align the thrust reverser cowl door hinges with the hinges on the crossover beams of the pylon, and install the four hinge bolts, first at position four, then at positions one, two and three. Next, remove the hoisting fixture from the hinge upper beam and keep the lower two sling points attached. Using the hoist, lift the door to the maximum open position. Extend the rear and FWD hold-open rods and make sure that they are correctly engaged. Remove the thrust reverser sling from the lower hoisting points. After that, remove the dust cover from the quick disconnect and connect the hydraulic hose from a hand pump or service unit. Inside the thrust reverser half gain access to the mounting bracket of the thrust reverser cowl door opening actuator. Position the cowl door opening actuator, and attach it to its mounting bracket on the thrust reverser cowl door. Then remove the protective cap from the opening actuator hydraulic connector, and connect the hydraulic manifolds. Using the hydraulic service units or hand pump pressurize the actuator to bleed the air. When finished, tighten and torque the hydraulic manifold connector. Then reinstall the protective shroud. On the opposite side of the engine, gain access to the opening actuator hinge beam on the pylon, and using the hydraulic service units, extend the opening actuator rod to the hinge beam. Align and attach it. Next close the thrust reverser cowl door by operating the hydraulic service unit. On the engine bottom centerline, engage and latch correctly both thrust reverser halves together. On the pylon area, finish tightening the hinge bolts and torque them at all positions. On the thrust reverser system, remove the dust cover of the hydraulic deploy hose. Use a container to collect the drained hydraulic fluid, then insert the reverser flexible shaft into the deploy hose, and connect the deploy hose to the thrust reverser upper actuator. In the same way, connect the thrust reverser retract hose. On the thrust reverser system electrical receptacle, reconnect the electrical connector. On the pylon area, reinstall the hinge access panel, and the pylon fairings. Finally, return the A/C to the initial configuration as defined in the close-up subtasks.

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THRUST REVERSER COWL DOOR REMOVAL/INSTALLATION - INSTALLATION

MAINTENANCE OPERATIONS (2)

COMMON NOZZLE ASSEMBLY - REMOVAL/INSTALLATION

The Common Nozzle Assembly or CNA can be removed easily. Place the special dolly in position, and raise the support up to the CNA, loosen and remove the 56 bolts which fix the CNA to the engine flange. Disconnect it. Then lower the assembly and move it away from the engine. For transportation, it is recommended to attach the CNA to its support. With the CNA removed it is now possible to see the exhaust plug in detail. The installation is the reverse procedure.

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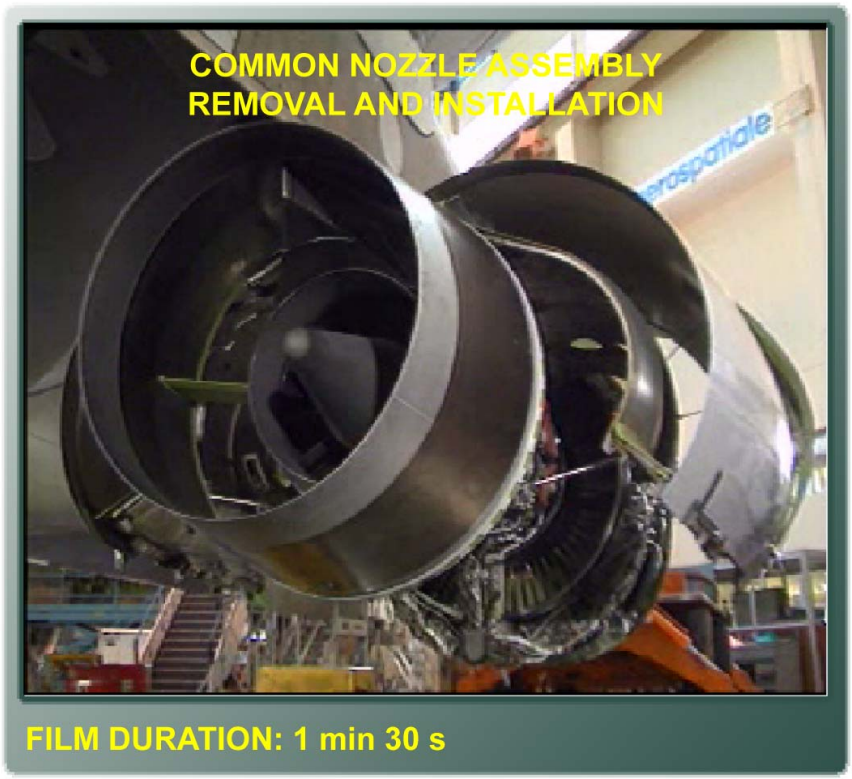

COMMON NOZZLE ASSEMBLY - REMOVAL/INSTALLATION

MAINTENANCE OPERATIONS (2)

AIR INTAKE COWL - REMOVAL/INSTALLATION

WARNING: BE CAREFUL DURING THE REMOVAL AND INSTALLATION OF THE AIR INTAKE COWL, IT WEIGHS 238 LBS (108 KG).
DO NOT GET THE CLEANING FLUID ON YOUR SKIN, IN YOUR EYES OR IN YOUR MOUTH, THE CLEANING FLUID IS POISONOUS. FLUSH CLEANING FLUID FROM YOUR EYES, MOUTH OR SKIN WITH WATER.
USE ONLY IN AN AREA OPEN TO THE AIR.

To remove the air inlet cowl, the fan cowl doors must be opened. Connect the special sling to a hoist, and attach the sling to the air inlet cowl hoisting points. Using the hoist, hold up the weight of the cowl and remove the bolts, then disconnect the pressure tube and electrical connectors of the P2/T2 sensor and remove the coupling at the anti-ice duct connection. Move the air inlet cowl FWD to disengage it. Then carry up and lower it on to its support. The air inlet cowl installation is the reverse procedure. During the installation take care that the inlet cowl locating pins engage correctly to the front engine flange. Then install and tighten the bolts. Finally, reconnect everything up and remove the sling equipment.

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AIR INTAKE COWL - REMOVAL/INSTALLATION

MAINTENANCE OPERATIONS (2)

FAN BLADE - REMOVAL/INSTALLATION

CAUTION: Do not let tools, parts or unwanted materials fall on the air intake cowl surface when you use the work mat. To prevent this, seal the edges of the work mat with tape before you use it. Be careful during the removal of the front blade retaining ring and the stage 1 fan blade, they each weigh approximately 10 LBS (4.5 KG).
Do not put any tools or parts that are removed in the stage 1 fan disk inner surface.
Be careful during the installation of the front blade retaining ring and the stage 1 fan blade, they each weigh approximately 10 LBS (4.5 KG).

WARNING: DO NOT LET ENGINE OIL STAY ON YOUR SKIN A LONG TIME, IT IS POISONOUS AND CAN GO THROUGH YOUR SKIN AND INTO YOUR BODY.

An individual fan blade can be changed easily if it is damaged, in this case, the fan blade must be changed with the same moment weight. First, remove the inlet cone. With the inlet cone removed, the front blade retaining ring is now accessible to remove it. Remove the 22 bolts which secure the annulus fillers between the fan blades and the 36 bolts which maintain the front blade retaining ring. Next, install puller bolts at six hole positions, and tighten them. Using these puller bolts, release the front blade retaining ring from the stage one fan disk. Turn the fan so that the blade to be removed is at twelve o'clock position. Then remove the two annulus fillers of the corresponding blade. Pull the blade forward along the dovetail slot and remove it.

NOTE: Note that the moment weight of the fan blade is identified on the bottom face of the blade root.

For the installation, align the replacement blade with the disk dovetail and install the two annulus fillers to their initial position. Reinstall the front blade retaining ring and secure it. Next install the 22 bolts which fix the annulus filler. Finally, reinstall the inlet cone and leave the work area making certain that it is clean and clear of tools and other items.

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FAN BLADE - REMOVAL/INSTALLATION

MAINTENANCE OPERATIONS (2)

FAN MODULE - REMOVAL/INSTALLATION

WARNING: BE CAREFUL DURING THE REMOVAL AND INSTALLATION OF THE FAN MODULE, IT WEIGHS APPROXIMATELY 395 LBS (179 KG).
PUT APPROVED GLOVES ON YOUR HANDS BEFORE YOU HOLD THE FAN BLADES. THE LEADING EDGES OF THE FAN BLADES CAN CAUSE INJURY TO YOUR HANDS.
BE CAREFUL DURING THE ASSEMBLY OF THE CANTILEVER SLING AND THE SLING ADAPTER, THE SLING WEIGHS 165 LBS (75 KG) AND THE ADAPTER WEIGHS 74 LBS (34 KG).
DO NOT GET ENGINE OIL ON YOUR SKIN FOR A LONG TIME, THE OIL IS POISONOUS AND CAN GO THROUGH YOUR SKIN AND INTO YOUR BODY.

CAUTION: Do not touch the stage 1 fan disk with tools when you loosen or remove the curvic coupling bolts.
There are twenty-four curvic coupling bolts which attach the fan module to the LP compressor/intermediate case module. During removal of the fan module, keep three of the bolts in position until after the installation of the support and slinging tools. Observe the correct untorque procedure and place the hub protector.
Make sure that the quick-release pin is installed in the inner holes in the cantilever sling bracket before moving the fan module/slinging assembly.
Put two persons on each side of the fan module before moving the fan module/sling tool assembly.
Make sure that the quick-release pin is installed in the inner holes in the cantilever sling bracket before moving the fan module/slinging tool assembly.
Do not touch the stage 1 fan disk with tools when you install or tighten the curvic coupling bolts.
Do not use a power wrench to tighten the bolts. The use of a power wrench can cause damage to the bolts. When you torque the curvic coupling bolts, it is important that the torque value is on the increase. A new bolt must be installed if the torque value is constant or decreases.

For this operation, the air inlet cowl must be removed first, then remove the inlet cone and its fairing. There are 25 curvic bolts which attach the fan module. Put hub protectors and remove 21 out of 24 bolts observing the unscrew procedure. The three bolts adjacent to the guide pins of the stub shaft remain in position. Next, the hub protectors are removed to install the sling adapter. Then the sling adapter is fixed. Using the hoist, connect the cantilever sling to the sling adapter. Secure the sling adapter with a quick-release pin. Using the adjustment handle, align the hoisting plate to the witness mark. Remove the remaining three curvic bolts and carefully move FWD the fan assembly making sure that nothing hits against the fan case. The fan module is reinstalled with the same precautions. Use the correlation mark and the U slot of the stub shaft to align the fan disk. Make sure that the fan module is correctly engaged and secure it with the curvic bolts at two, four, eight and ten o'clock position. Then remove the sling adapter with the cantilever sling. Install and tighten the other curvic bolts. Finally, reinstall the air inlet cowl and the inlet cone. When leaving the work area, make sure that the air intake is clear and clean of tools.

UGB13131 - U7ST0M0 - UM70Y6IAE000001

FAN MODULE - REMOVAL/INSTALLATION

MAINTENANCE OPERATIONS (2)

ENGINE BORESCOPE - INSPECTION/CHECK

WARNING: IF YOU GET FLUID ON YOUR SKIN OR IN YOUR EYES, FLUSH IT AWAY WITH CLEAN WATER AND GET MEDICAL AID.
MAKE SURE THAT THE BLANKING PLUG IS SUFFICIENTLY COOL BEFORE REMOVAL, THE TEMPERATURE STAYS HIGH FOR A SHORT TIME AFTER ENGINE SHUTDOWN.
IF YOU GET FLUID ON YOUR SKIN OR IN YOUR EYES, FLUSH IT AWAY WITH CLEAN WATER AND GET MEDICAL AID.

CAUTION: Be careful during installation and removal of the guide tube not to cause damage to the outer or inner outlet guide vanes.
The limits which follow are applicable on a continuing service basis only. Each limit is based on what the structure of the vane must be and does not indicate that there will not be deterioration of the engine performance, stability, operating limits or part repairability.
Make sure that the borescope tip is not in the path of the stage 1 High Pressure Turbine (HPT) blades before rotating the engine.

We will now see a presentation of the borescope equipment. First of all a rotator kit is installed on the cranking pad near the starter for manual drive of the High Pressure (HP) rotor, then to inspect the affected sections, the corresponding borescope port covers have to be removed. Here are the borescope port covers removed from the HP compressor stage 3, stage 4, stage 7 and 8, stage 9 and 10, stage 11 and 12, and the HP turbine stage 1 and 2, stage 2 and LP turbine, the borescope inspection requires skill and competence. When inserting the borescope probe, we can examine the blades, and by turning the compressor we can detect if there are some cracks, nicks or tip damages. Here the operator is inspecting the HP turbine first stage vanes through an igniter port, and here we can see the leading edge of the HP turbine first stage blades. In fact, it is through this unit and an optic fiber that the pictures can be picked up and transmitted.

ENGINE BORESCOPE - INSPECTION/CHECK

MAINTENANCE OPERATIONS (2)

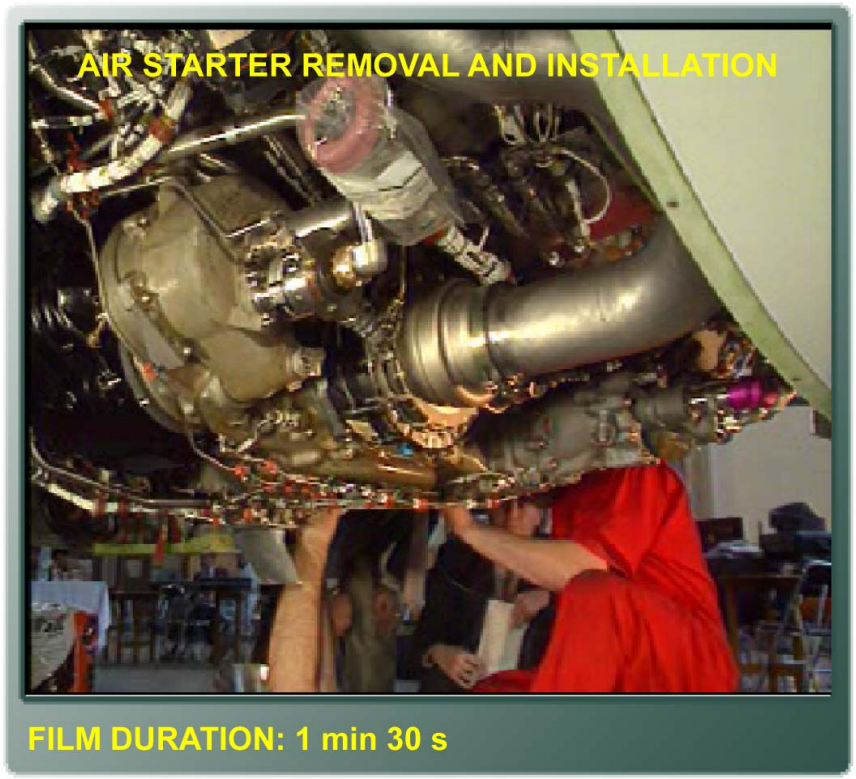
AIR STARTER - REMOVAL/INSTALLATION

WARNING: DO NOT LET ENGINE OIL STAY ON YOUR SKIN FOR A LONG TIME, THE OIL IS POISONOUS AND CAN GO THROUGH YOUR SKIN AND INTO YOUR BODY. BE CAREFUL DURING REMOVAL OR INSTALLATION OF THE STARTER, IT WEIGHS 33 LBS (15 KG).

CAUTION: During installation of the air duct, do not put more stress than is necessary on the duct.

In case of mechanical rupture or failure, the air starter can be easily removed on line. First release the clamp of the lower air duct at the air starter inlet junction and discard the gasket. Hold the air duct and release the clamp at the start valve outlet junction then remove the air duct and the clamps. Release the quick-detach clamp and disconnect the starter from its adapter housing. With the starter removed, it is possible to see the drive pad and the splines of the adapter where the starter is engaged. Also on the starter you can see the turbine rotor section, the engagement splines and drive shaft. The installation of the starter is the reverse procedure.

NOTE: Note: During this task, new gaskets must be installed.



AIR STARTER - REMOVAL/INSTALLATION

MAINTENANCE OPERATIONS (2)

IDG - REMOVAL/INSTALLATION

WARNING: BE CAREFUL DURING THE REMOVAL OR THE INSTALLATION OF THE INTEGRATED DRIVE GENERATOR (IDG), IT WEIGHS 124 LBS (60 KG). DO NOT LET ENGINE OIL ON YOUR SKIN FOR A LONG TIME, THE OIL IS POISONOUS AND CAN GO THROUGH YOUR SKIN AND INTO YOUR BODY. DO NOT TOUCH THE FUEL OR OIL SYSTEM COMPONENTS FOR A SHORT TIME AFTER THE ENGINE SHUTDOWN, THE ENGINE COMPONENTS STAY HOT FOR SOME TIME AND CAN CAUSE INJURY.

CAUTION: Do not let engine oil fall on the engine, unwanted oil must be removed immediately. The oil can cause damage to the surface protection and to some parts.
Help the IDG out in a straight line, the input shaft can catch and cause damage to the input seal. Do not use external parts or tools to pull the IDG from the gearbox, they can cause damage.
Do not apply side loads which could bend the splined drive shaft during the installation of the IDG. A bent splined drive shaft will prevent correct installation of the IDG and damage it in operation. Make sure that you do not damage the input seal during the installation of the IDG.
Make sure that the tubes are not stressed, this can cause damage.
The square washers must be installed between the phase cables and the terminal block on the IDG to prevent the terminal block becoming hot and causing damage to the IDG.

Before removing the IDG, the engine must be shut down for at least 5 minutes to prevent burns because the oil stays hot for a few minutes. First of all, the IDG must be drained and the oil tubes disconnected and removed. Also remove the banjo couplings and note their initial positions. Then disconnect the three electrical connectors from the IDG. Remove the cover plate of the IDG terminal box and disconnect the output cables. Next place the special dolly in position and raise it up to the IDG. When the IDG is on the dolly, release the quick-attach/detach coupling then pull the IDG FWD to disengage it. Let's now see the IDG installation. Using the dolly, lift the IDG up to its position and align the open marks on the quick-attach/detach coupling. When the IDG is engaged, tighten the coupling sufficiently to secure it, then remove the dolly, reconnect the electrical connectors and reinstall the oil tubes.

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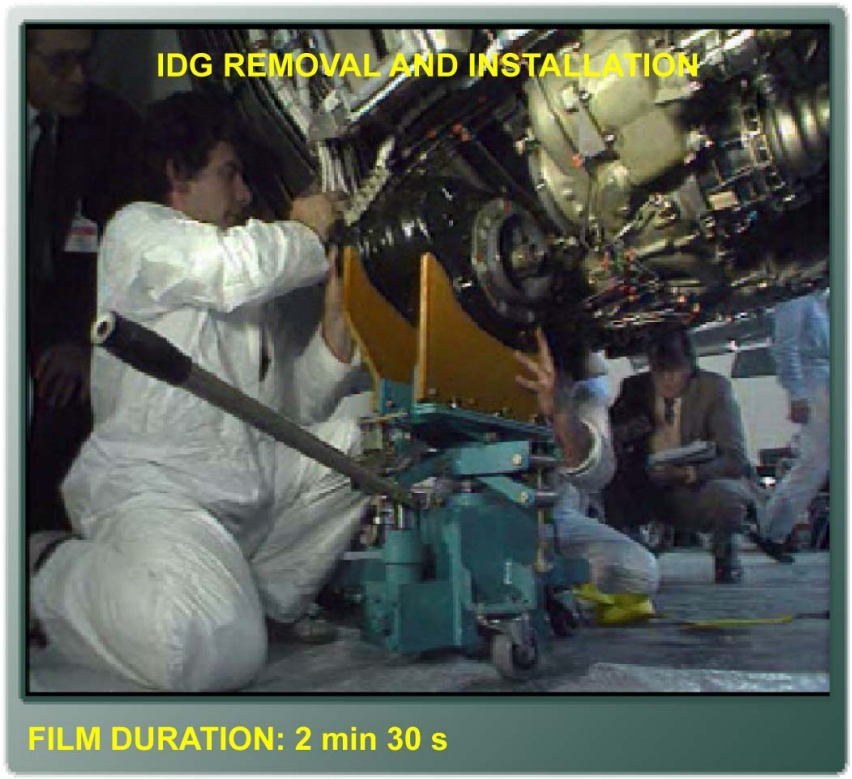

IDG - REMOVAL/INSTALLATION

MAINTENANCE OPERATIONS (2)

IDG - SERVICING

WARNING: DO NOT LET ENGINE OIL STAY ON YOUR SKIN FOR A LONG TIME, THE OIL IS POISONOUS AND CAN GO THROUGH YOUR SKIN AND INTO YOUR BODY.
YOU MUST PUT THE DRAIN HOSE INTO A CONTAINER BEFORE YOU CONNECT THE DRAIN HOSE TO THE OVERFLOW DRAIN VALVE. MAKE SURE THAT THE DRAIN HOSE HANGS DOWN VERTICALLY AND THE END OF THE HOSE IS ABOVE THE OIL LEVEL IN THE CONTAINER. WHEN YOU CONNECT THE DRAIN HOSE TO THE IDG, YOU RELEASE THE OIL PRESSURE AND OIL WILL SPRAY FROM THE DRAIN HOSE.
YOU MUST PUT THE DRAIN HOSE ON THE OVERFLOW DRAIN VALVE BEFORE YOU REMOVE THE CASE DRAIN PLUG. THE INSTALLATION OF THE DRAIN HOSE RELEASES THE PRESSURE IN THE IDG OIL SYSTEM.
YOU MUST PUT THE DRAIN HOSE ONTO THE OVERFLOW DRAIN VALVE BEFORE YOU REMOVE THE CASE DRAIN PLUG. THE INSTALLATION OF THE DRAIN HOSE RELEASES THE PRESSURE IN THE IDG OIL SYSTEM.

CAUTION: Do not let engine oil fall on the engine, unwanted oil must be removed immediately. The oil can cause damage to the surface protection and to some parts. The drain hose must be connected to let the oil in the IDG drain to the correct level. The IDG can become too hot if it contains too much oil. Do not operate the IDG without sufficient or with too much oil, this will cause damage to the IDG. When you service the IDG oil system, do not mix types or brands of oil.
Let the temperature of the IDG decrease to 120°F (48,8°C) or less before you drain the oil.

Do not touch the IDG system components for a short time after the engine is shut down. The engine components stay hot for some time and can cause injury. If the oil is below the minimum level, the green band, add oil to the IDG. Now prepare the IDG for servicing. Remove the caps from the overflow drain and pressure fill valves. First connect a drain hose to the overflow drain valve then connect the pressure fill hose from a service unit to the pressure fill valve. Using the service units, add oil, until the level reaches the full mark and the oil overflows through the drain hose. Drain oil until the oil level moves down to the green band. Remove the drain and pressure fill hoses from connectors and reinstall the caps. Finally perform a leak test. Do another check of the oil level 5 minutes later.

NOTE: This procedure is to let the air escape from the IDG oil system and to let the oil flow around the system.

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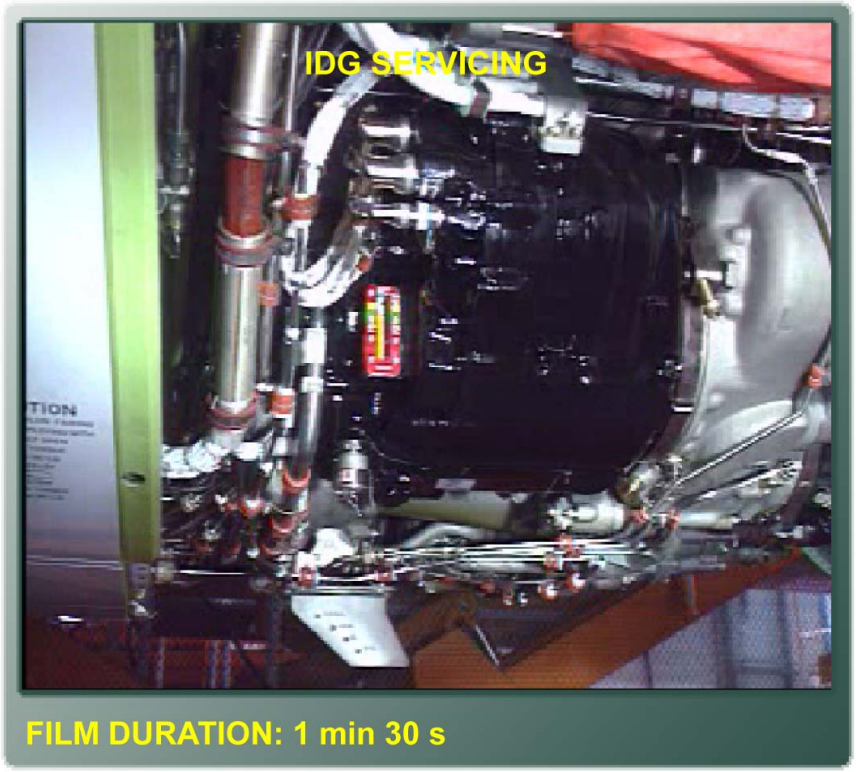


IDG - SERVICING

POWER PLANT SYSTEM LINE MAINTENANCE (2)

ENGINE OIL SERVICING

CAUTION: Caution: The engine should be shut down for at least 5 minutes prior to oil servicing. This allows the residual pressure in the oil tank to decrease. If you open the filler cap when there is pressure in the tank the hot oil can spray out and burn you.

NOTE: Note: If possible, the engine oil should be checked and serviced within 5 to 60 minutes after shutdown.
Note: If the engine has been shutdown more 1 hour but less than 10 hours, start the engine and run at idle for 3 minutes prior to servicing.
Note: If the engine has been shut down for 10 hours or more, you must dry crank the engine followed by an engine start and idle run of at least 3 minutes duration. This is to ensure that the oil level shown in the tank is correct before oil is added.

- open engine oil service door on left fan cowl,
- check oil level on the sight gage on the oil tank,
- raise filler cap handle to vertical (unlocked position),
- turn the oil filler cap to remove,
- add oil as necessary up to the FULL mark on the sight gage,
- install oil filler cap - make sure to LOCK the cap.

NOTE: Note: It is also possible to Pressure Fill the engine oil. Two ports are installed on the oil tank, one for pressure and one for overflow. See AMM for procedure.

V2500

OIL FILLER CAP

OIL SIGHT GLASS

ENGINE OIL SERVICE DOOR

ENGINE OIL SERVICING

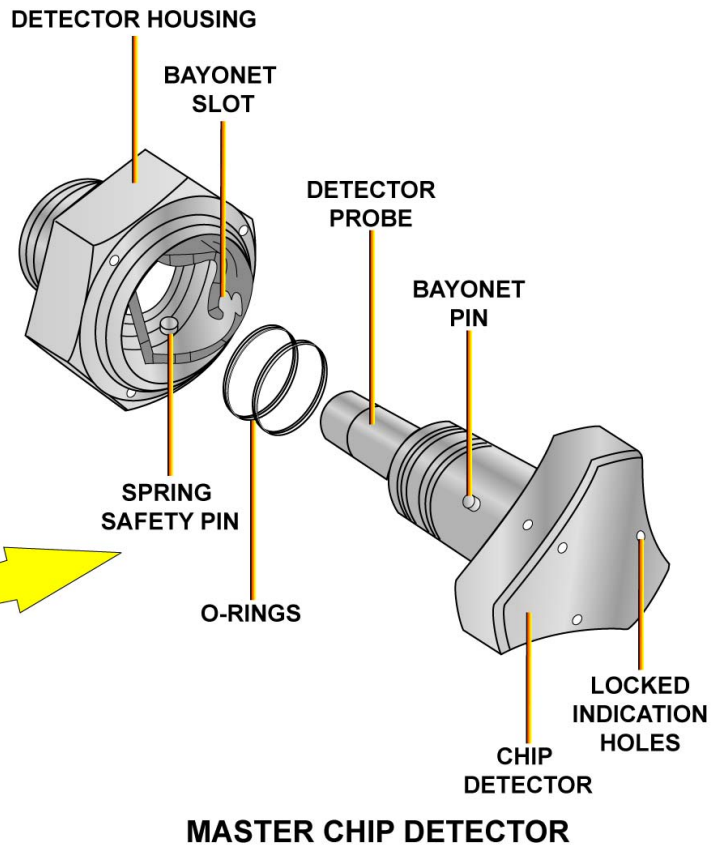
POWER PLANT SYSTEM LINE MAINTENANCE (2)

MASTER CHIP DETECTOR CHECK

The Master Magnetic Chip Detector (MCD) is located on the oil scavenge filter housing attached to the oil tank. The probe will collect any magnetic particles in the oil system. To check for contamination, remove the Master MCD first:
- open rear access door at left fan cowl,
- push in and turn the MCD plug counterclockwise,
- check the AMM for examples of NORMAL and ABNORMAL contamination

NOTE: Note: NO CONTAMINATION on Master MCD - No maintenance required.
Note: CONTAMINATION on Master MCD - Inspect ALL other MCD's.

- clean the MCD,
- replace seal ring and re-install - check that the RED marks are aligned.



MASTER CHIP DETECTOR CHECK

POWER PLANT SYSTEM LINE MAINTENANCE (2)

MASTER CHIP DETECTOR CHECK (continued)

ADDITIONAL CHIP DETECTORS

Additional magnetic chip detectors are installed in the oil system to isolate the source of metallic debris.

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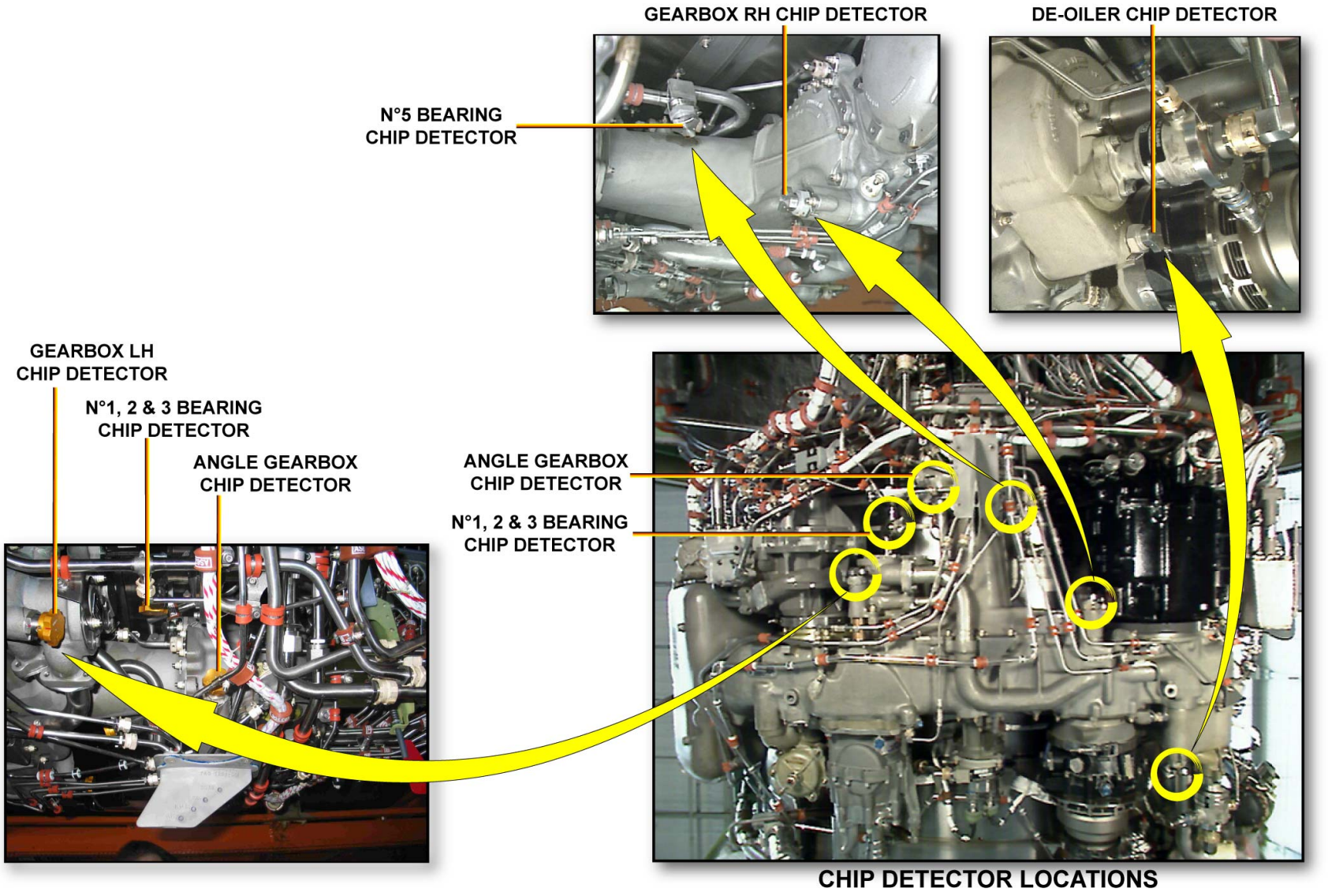

MASTER CHIP DETECTOR CHECK - ADDITIONAL CHIP DETECTORS

POWER PLANT SYSTEM LINE MAINTENANCE (2)

MEL / DEACTIVATION

FUEL FILTER CLOGGING

In case of a failure of the FUEL CLOG warning on ECAM, the aircraft may be dispatched per MEL as long as the fuel filter is changed once each day. The filter housing is part of the fuel cooled oil cooler on the fan case LH side. Procedure:
- FADEC GND PWR selected OFF,
- open LH fan cowl,
- drain residual fuel using drain plug,
- open filter cover to remove and replace fuel filter element and o-rings,
- close filter cover. Check AMM for correct torque value for filter cover bolts,
- perform minimum idle check for leaks,
- close fan cowl.

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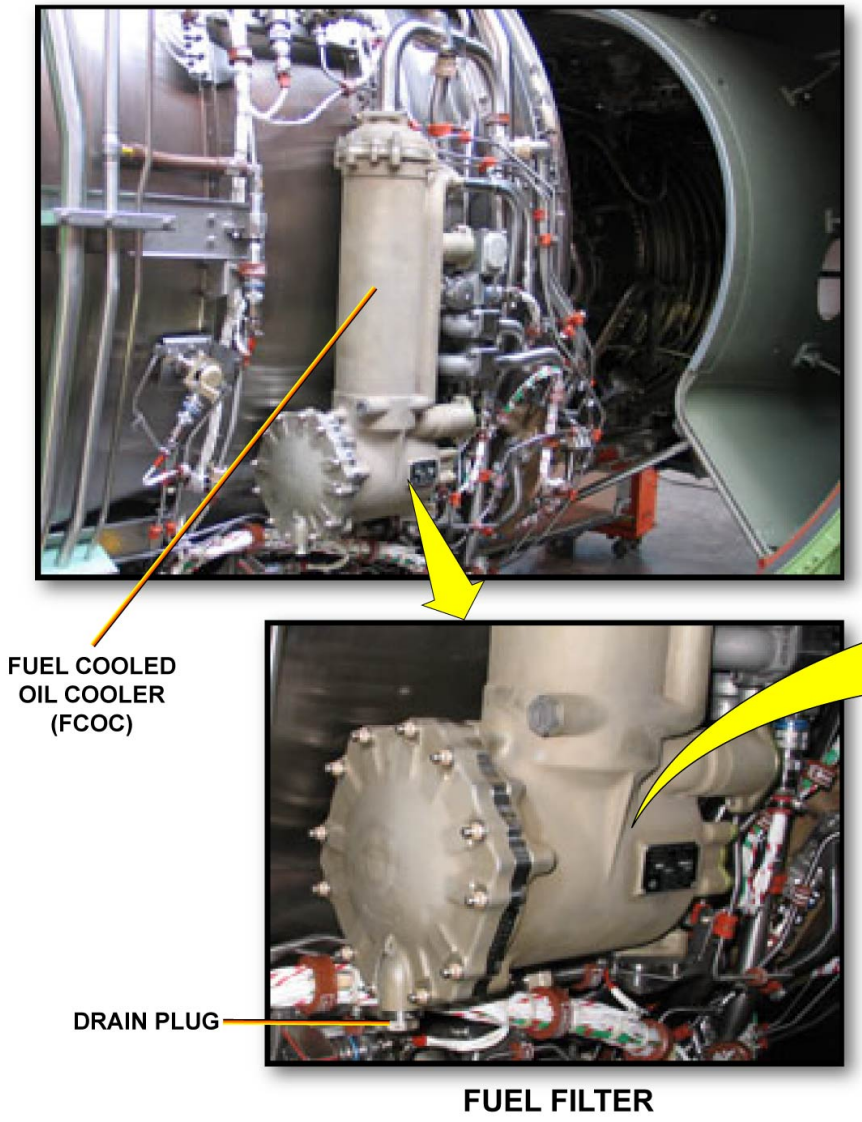
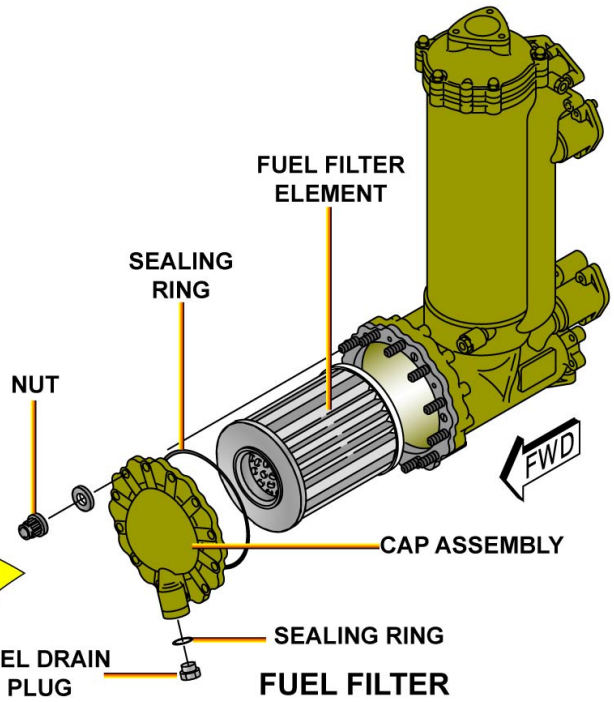


FUEL FILTER



FUEL FILTER

MEL / DEACTIVATION - FUEL FILTER CLOGGING

POWER PLANT SYSTEM LINE MAINTENANCE (2)

MEL / DEACTIVATION (continued)

T/R DEACTIVATION AND LOCKOUT

Per the MEL, one or both Thrust Reversers may be deactivated in the STOWED position for dispatch. The deactivation procedure has two parts. First, the Hydraulic Control Unit (HCU) is deactivated. Moving the deactivation lever to the inhibit position prevents the pressurizing valve from supplying hydraulic pressure to the reverser actuators. In the second part of the deactivation procedure each translating sleeve is secured (bolted) to the reverser structure preventing any movement.

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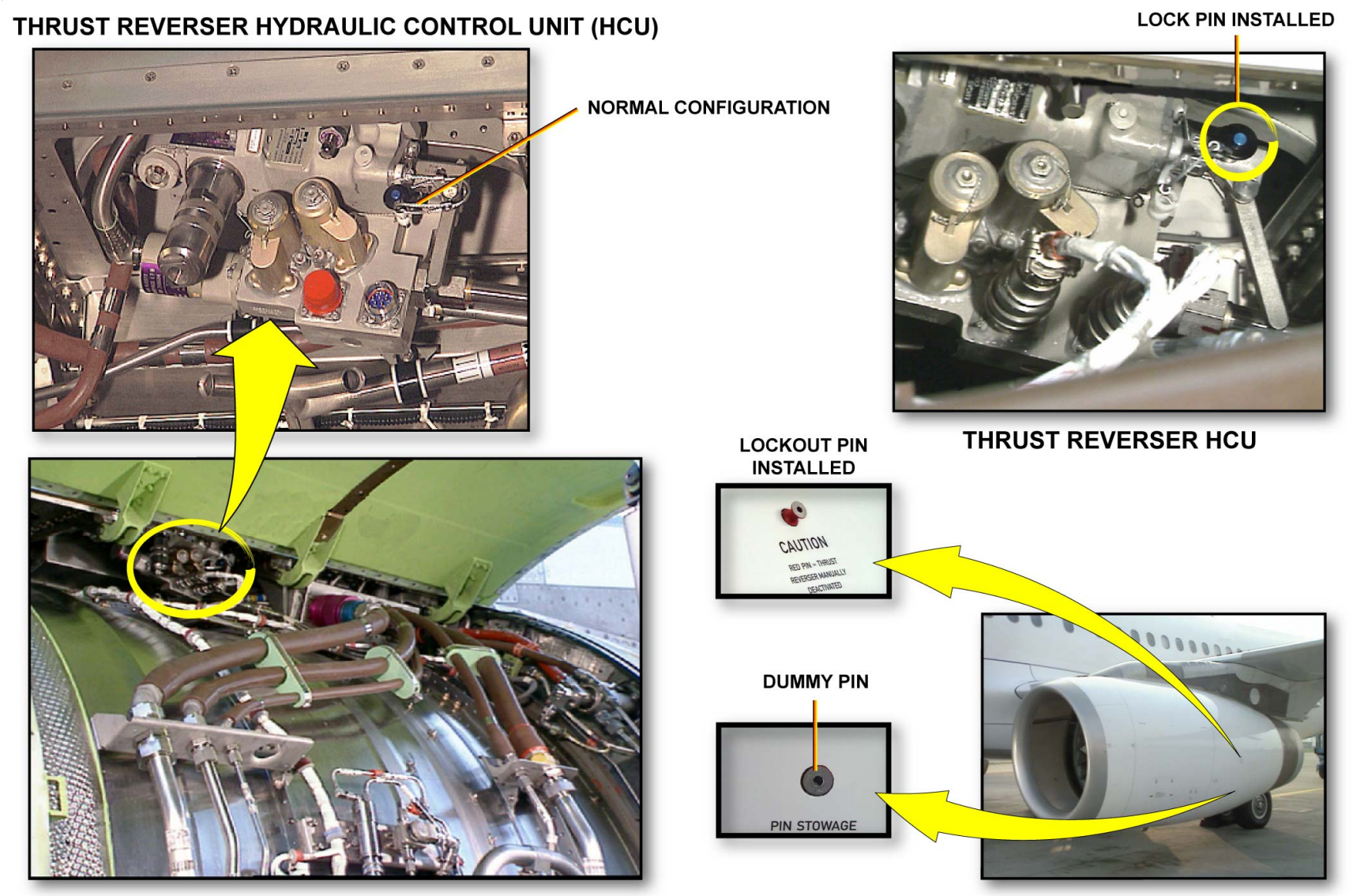

MEL / DEACTIVATION - T/R DEACTIVATION AND LOCKOUT

POWER PLANT SYSTEM LINE MAINTENANCE (2)

MEL / DEACTIVATION (continued)

START VALVE MANUAL OPERATION

In case of an electrical failure of the start valve, the valve may be operated manually to start the engine. The aircraft may be dispatched per the MEL with the valve INOP closed.

NOTE: Note: Do not operate the valve unless the starter system is pressurized. Damage to the valve can occur.

- open the start valve access door on the RH cowl,
- establish communications with the cockpit (Interphone jack on engine inlet cowl),
- on command from the cockpit, Use a 3/8" square drive to move the start valve manual handle to the OPEN position.

NOTE: Note: Make sure you maintain pressure against the spring tension to keep the valve open.

- after engine start, on command from the cockpit, move start valve manual handle to CLOSED. Make sure that the start valve is fully closed.

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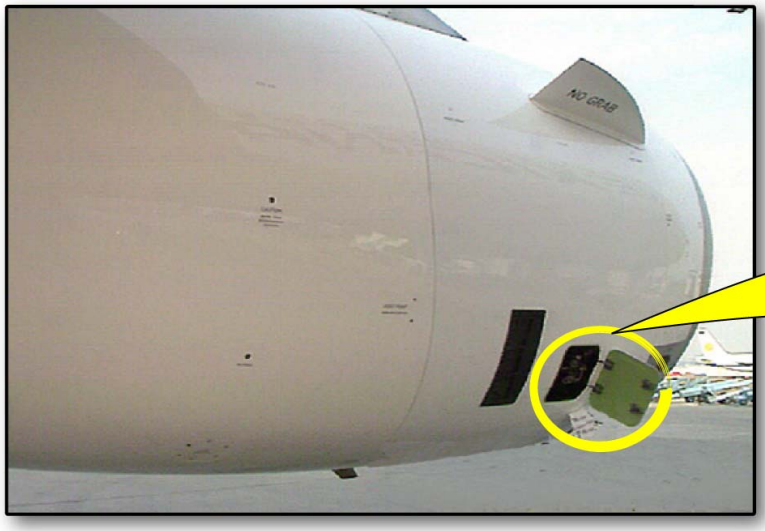
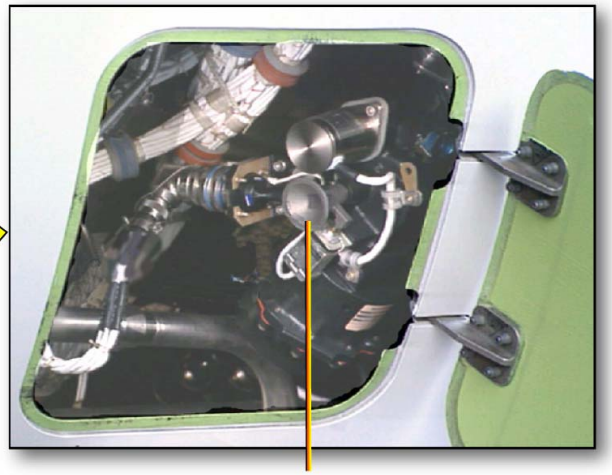


V2500

START VALVE ACCESS DOOR



START VALVE MANUAL
SQUARE DRIVE ACCESS

START VALVE MANUAL OPERATION — **FCOM Volume 3**

Advise ground crew to prepare for manual start operation.

- AUDIO CONTROL PANEL ..... CAB
  - When ground crew member is ready, order "START 1 or 2"
- ENG MODE SEL ..... IGN
- ENG MASTER ..... ON
- START VALVE....."ORDER OPEN AND KEEP OPEN"
  If not maintained in OPEN position by the ground crew member, the start valve closes.
  - When N2 at 43 %
- START VALVE....."ORDER CLOSE"
  Continue with normal procedure

MEL / DEACTIVATION - START VALVE MANUAL OPERATION

POWER PLANT SYSTEM LINE MAINTENANCE (2)

MEL / DEACTIVATION (continued)

TEST SET OF 7TH and 10TH STAGE BLEED VALVE AND SOLENOID

When you do the test of the bleed valve, listen carefully to the bleed valve. If necessary, use the stethoscope supplied with the test set. If possible, use a light source (torch and mirror) to see the movement of the bleed valve.

If you hear a click when the bleed valve closes or if you see the bleed valve move, the test is correct (PASS). If there is no movement of the bleed valve, the test is not correct (FAIL). If you are not sure, remove the silencer and do an inspection for physical movement.

To do the test of the solenoid, it is important to put a WARNING NOTICE(S) to tell persons not to start the engine. Use the hand pump to get 20 psi on the solenoid input pressure gauge.

Read the value on the solenoid output pressure gauge. The test is correct (PASS) if the solenoid output pressure increases quickly to +0/-5 psi of solenoid input pressure. It is possible that the pressure on the two gauges will slowly decrease. If the pressure continues to decrease for more than 5 seconds, this is acceptable.

The test is not correct (FAIL) if the difference between the solenoid output pressure and the solenoid input pressure is more than 5 psi. If the pressure decreases for less than 5 seconds, reject the solenoid.

Then, the Green CONTINUITY light comes on and the solenoid output pressure is zero. (It is possible that the solenoid output pressure gauge will momentarily show a pressure value when the TEST SWITCH pushbutton is pushed. This is acceptable.)

If the CONTINUITY light does not come on or if the solenoid output pressure is more than zero, the test is not correct (FAIL) (it is possible that an indication will be shown momentarily when you push the TEST SWITCH pushbutton for the first time. This is acceptable.)

The input pressure will gradually decrease while you continue to push the test set switch. This is acceptable.

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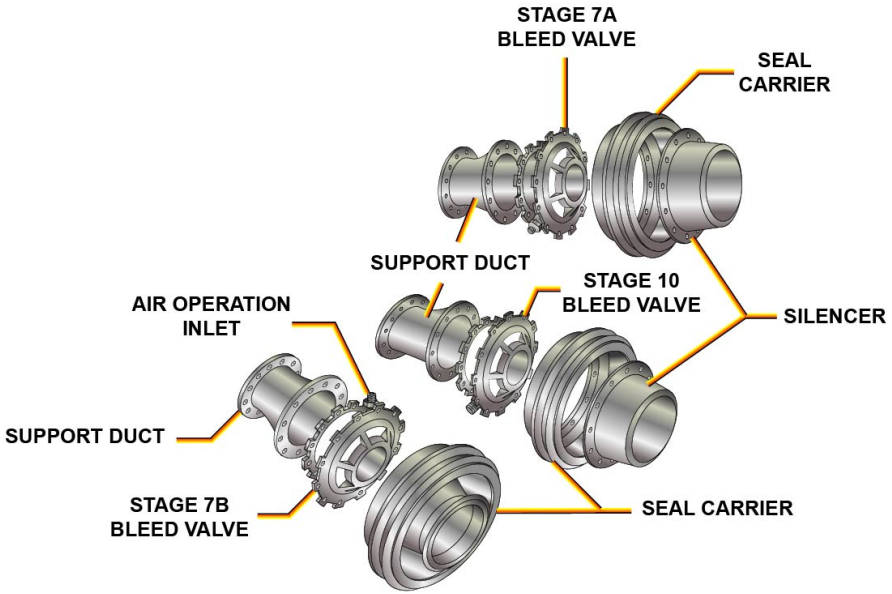

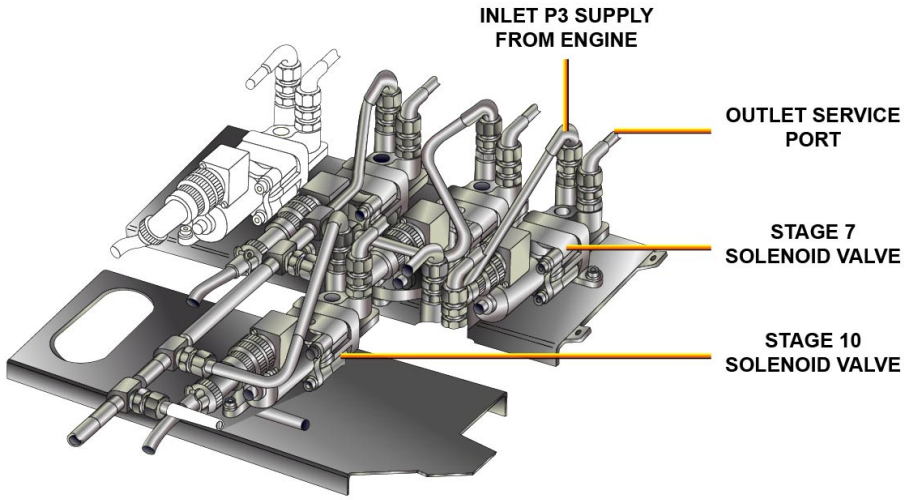

For IAE engines only.

MEL / DEACTIVATION - TEST SET OF 7TH AND 10TH STAGE BLEED VALVE AND SOLENOID

POWER PLANT SYSTEM LINE MAINTENANCE (2)

MAINTENANCE TIPS

The engine and pylon drain system is designed to collect fuel, oil, water and hydraulic fluid from engine systems and accessories and discharge them overboard through the engine drain mast and the pylon drain tubes. For troubleshooting and leak isolation the drain mast body has separate drains identified and visible with the cowls closed. The pylon drain tubes collect fluids from individual pylon chambers, also for leak isolation.
If fluid leaks are found during transit operations, run the engine at idle for 5 minutes. If the leak stops, the aircraft may be dispatched without maintenance action. If leaks continue after 5 minutes, consult the AMM (ATA 71-70) for maximum permitted leakage limits for all of the drains. There are 2 limits for each drain. If the first limit is exceeded, the aircraft may be dispatched and can continue to operate for a maximum of 25 hours or 10 flights as long as the second limit is not exceeded.
Here are some examples of engine drains with both leakage limits. See the AMM for complete list.

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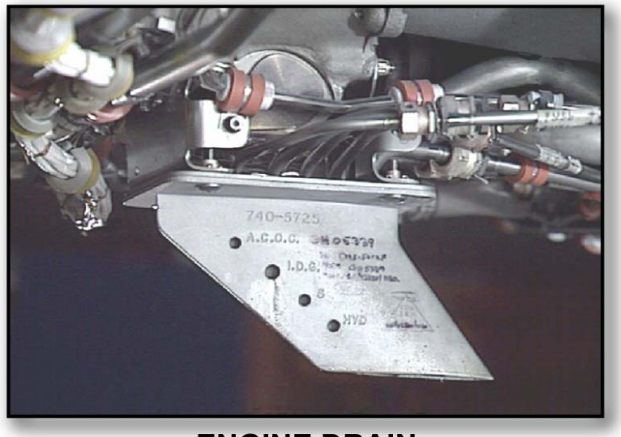
V2500

Examples of engine drains with both leakage limits.
See the AMM for complete list.

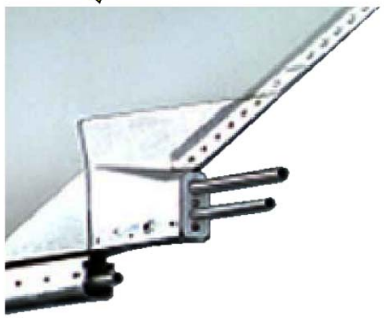
Fuel pumps
10 drops/minute
40 drops/minute

Fuel Metering Unit
0 drops/minute
40 drops/minute

HYDRAULIC pump
3 drops/minute
40 drops/minute



ENGINE DRAIN



PYLON DRAINS

MAINTENANCE TIPS

POWER PLANT SYSTEM LINE MAINTENANCE (2)

ENVIRONMENTAL PRECAUTIONS

Do not discharge products such as oil, fuel, solvent, lubricant either in trash bins, soil or into the water network (drains, gutters, rain water, waste water, etc...).
Sort waste fluids and use specific waste disposal containers.
Each product must be stored in an appropriate and specific cabinet or room such as a fire-resistant and sealed cupboard.

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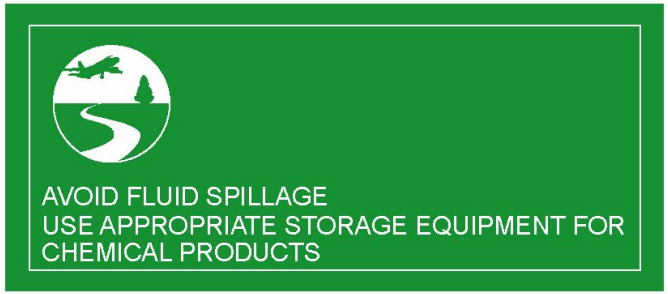
STORE PRODUCTS IN APPROPRIATE CONTAINER/CUPBOARD/ROOM

SORT WASTE FLUIDS IN CONTAINERS



FLUID SPILL CLEANUP KIT

USE SPECIFIC WASTE DISPOSAL CONTAINERS

ENVIRONMENTAL PRECAUTIONS

MANUAL OPERATION OF THRUST REVERSER SLEEVES (3)

PRECAUTIONS

CAUTION: Do not extend and stow the translating sleeves with the thrust reverser "C" ducts open. Damage to the translating sleeves, synchronizing system and the hinge access panels could occur. Do not use power tools in the manual drive sockets.

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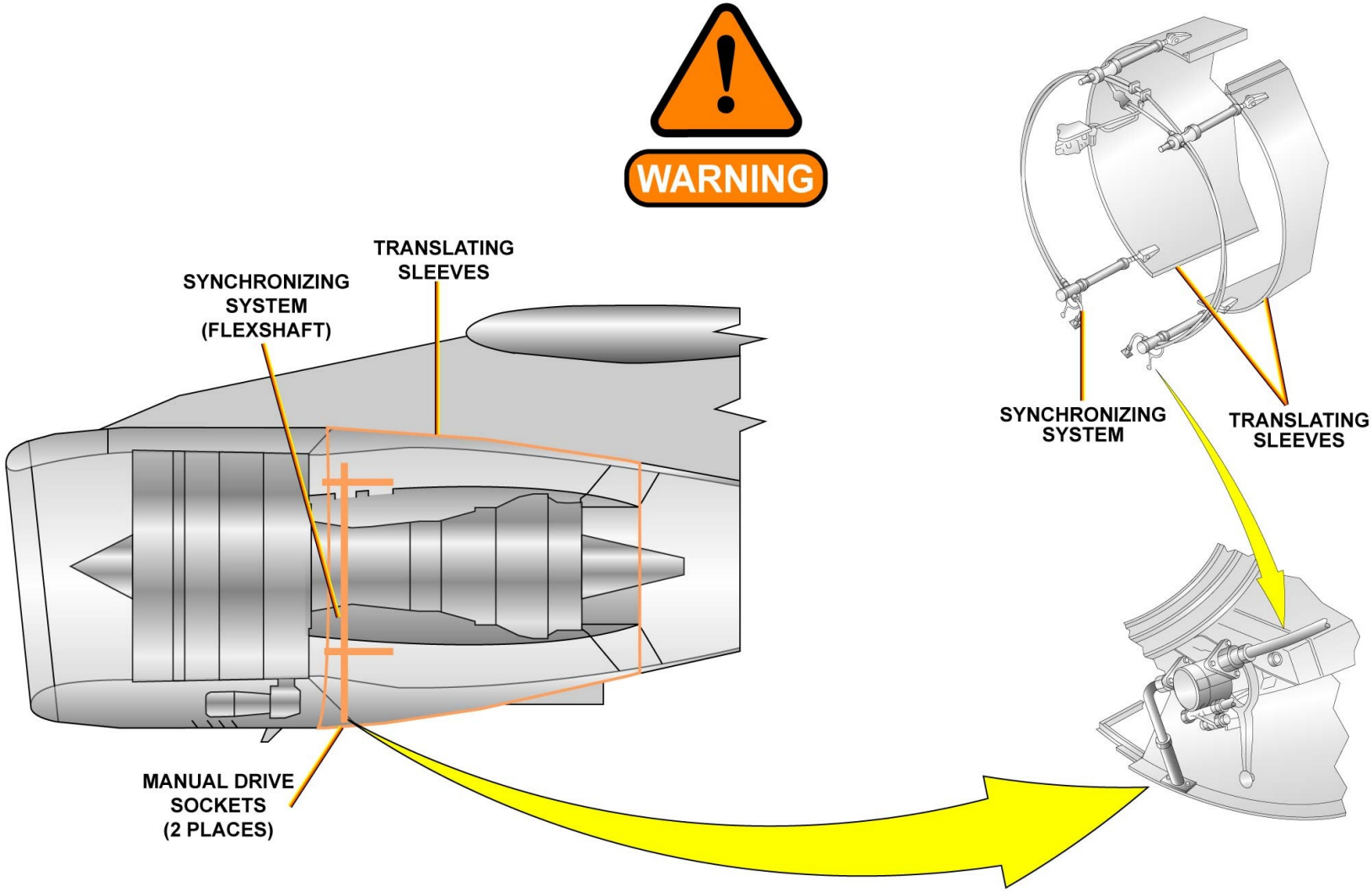

PRECAUTIONS

MANUAL OPERATION OF THRUST REVERSER SLEEVES (3)

MANUAL DEPLOYMENT and stowage procedure

Make sure that the A/C is in the same configuration as for the manual deploying task.

WARNING: THE THRUST REVERSER SYSTEM SHOULD BE DEACTIVATED USING THE HYDRAULIC CONTROL UNIT (HCU) LEVER, BEFORE WORKING ON THE SYSTEM OR ON THE ENGINE. IF NOT THE THRUST REVERSER CAN ACCIDENTLY OPERATE AND CAUSE SERIOUS INJURIES TO PERSONNEL AND/OR DAMAGE TO THE REVERSER.

Before the manual deployment of the translating sleeves some precautions have to be taken in the cockpit. On the ENGine START panel, check that the MASTER lever is at OFF position and install a warning notice. On the maintenance panel, make sure that the ENGine FADEC GrouND PoWeR SWitch is OFF and install a warning notice. Gain access to the HCU, move the lever to the OFF position to deactivate the thrust reverser system and install the safety pin. Gain access to the manually by-passable non-return valve by removing the corresponding pylon access panel. Now, move the non-return valve lever to the bypass position. After that, on the lower actuator move the lock lever to the unlocked position, this releases the actuator and permits manual deployment. Before operating, check that the flexible shaft is correctly engaged inside the manual drive, then insert a speed wrench into the manual drive shaft and deploy the translating sleeves. When looking FWD, you can see the blocker doors moving. With the translating sleeves deployed the cascades are accessible. To stow the translating sleeves, reverse the procedure. When the translating sleeves reach the fully stowed position the lock lever on the lower actuator automatically engages. Then return the manually by-passable non-return valve lever to the normal position and reactivate the thrust reverser system through the HCU lever. Finally, in the cockpit remove the warning notices.

NOTE: Both translating sleeves move together due to the synchronizing system.

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MANUAL DEPLOYMENT AND STOWAGE PROCEDURE

ENGINE REMOVAL AND INSTALLATION (3)

PRECAUTIONS

WARNING: MAKE SURE THAT YOU HAVE THE CORRECT FIRE FIGHTING EQUIPMENT AVAILABLE BEFORE YOU START ANY TASK ON THE FUEL SYSTEM.
MAKE SURE THAT THE L/G SAFETY-LOCKS AND THE WHEEL CHOCKS ARE IN POSITION.
PUT THE SAFETY DEVICES AND THE WARNING NOTICES IN POSITION BEFORE YOU START ANY TASK ON OR NEAR:
- THE FLIGHT CONTROLS,
- THE FLIGHT CONTROL SURFACES,
- THE L/G AND THE ASSOCIATED DOORS,
- ANY COMPONENT THAT MOVES.

MAKE SURE THAT ALL THE CIRCUITS IN MAINTENANCE ARE ISOLATED BEFORE YOU SUPPLY ELECTRICAL POWER TO THE A/C.

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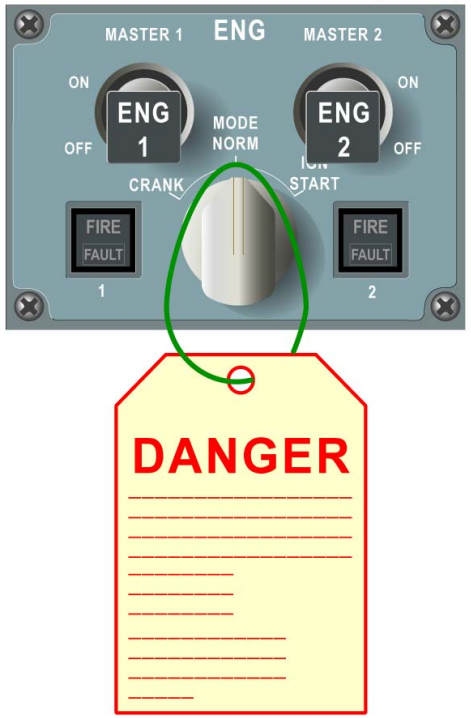

PRECAUTIONS

ENGINE REMOVAL AND INSTALLATION (3)

ENGINE REMOVAL

Before the removal operation the engine systems must be deactivated and isolated from the aircraft, and all the connections disconnected from the pylon interfaces. To support the cowl doors during the operation hold-open braces are installed. Then the engine trolley and cradle are placed under the engine. To support the engine during removal and transportation fixtures are installed at handling points on the fan case and also on the turbine rear frame. On the FWD engine mount, each bolt is loosened and retorqued to the maximum force an operator using a standard wrench can apply. The center hinge clamp of the FWD bootstrap is then fixed on the pyramid where hinge arms will be installed. The rear beam of the bootstrap equipment is fixed on the pylon lower part, then the dynamometers and chain pulley blocks are installed. Disconnect the engine cradle from the trolley and raise the cradle to the engine using the four chain pulley blocks. When the cradle reaches the engine handling points secure the supports on the front and on the rear parts. Loosen and remove the bolts of the FWD mount, then the bolts of the aft mount through an access provided when the hinge access panel is removed. Make sure that no lines or unions remain connected to the pylon and lower the engine using the four chain pulley blocks, also check that the engine mounts disengage correctly from their attaches. Slowly continue the descent until the cradle touches the trolley. Then secure and lock it. Remove the chain hoists and the FWD hinge arms, then the chain pulley blocks and dynamometers from the rear beam. Now push forward the engine from under the pylon, making sure that nothing catches. With the engine removed it is now possible to see the aft and FWD mounts in more detail and also the front hinge clamp and the rear beam installation. Notice the hold-open brace which holds the thrust reverser cowl door in the open position.

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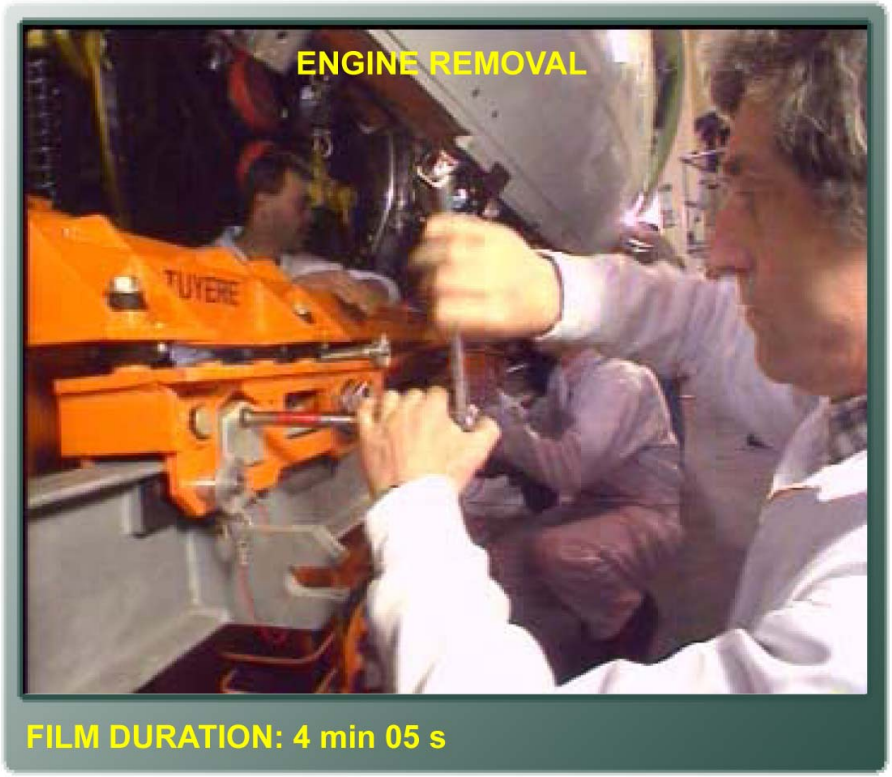

ENGINE REMOVAL

ENGINE REMOVAL AND INSTALLATION (3)

ENGINE installation

All the equipment is re-installed to provide the engine lifting. Start the lifting using the pulley levers and check that the dynamometers show the correct load. Raise the engine cradle gradually. As the engine reaches the pylon take care that the FWD and rear mounts engage correctly. Then install the bolts to both mounts and tighten them. Note that you never use the same bolts. Always change them for new or inspected ones. When the engine cradle is on the trolley remove the four chain pulley blocks and dynamometers, then the bootstrap equipment. Reconnect all lines and electrical harnesses to the pylon interfaces. Finally lock the cradle to the trolley. Push the trolley out from under the engine and remove the hold-open braces from the cowls. The engine can now be put back in serviceable condition.

NOTE: Avoid any dynamic effect during descent.

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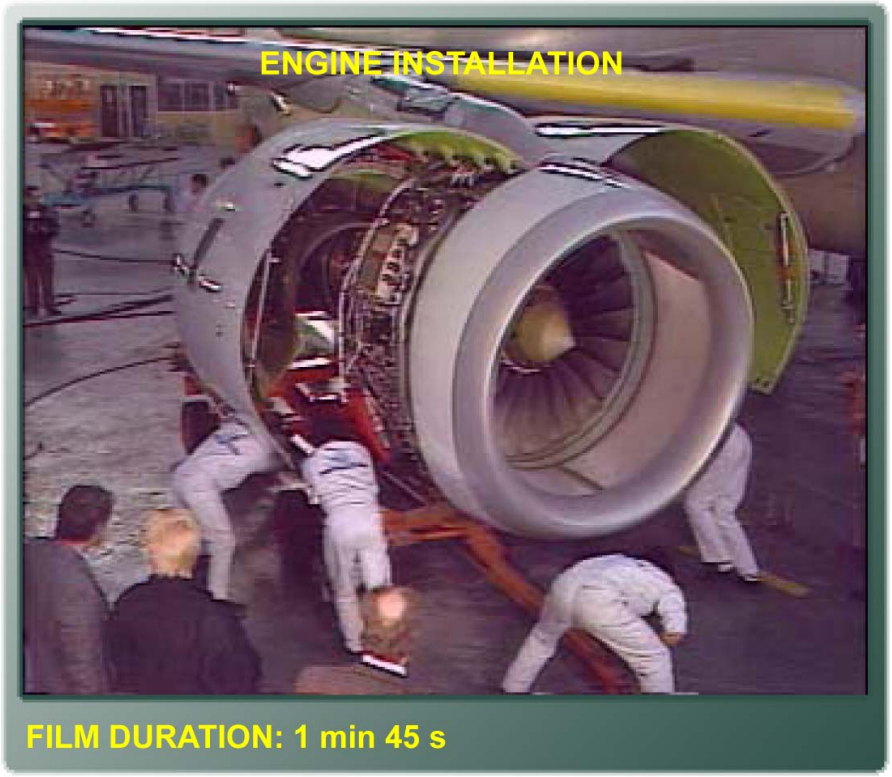

ENGINE INSTALLATION

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